

SEP 30 1916
UNIV. OF CHICAGO
LIBRARY

THE SCIENTIFIC MONTHLY

EDITED BY J. McKEEN CATTELL

CONTENTS

The Origin and Evolution of Life upon the Earth. Dr. HENRY FAIRFIELD OSBORN	313
The Development of Folk-tales and Myths. Dr. FRANZ BOAS	335
Thomas Jefferson in Relation to Botany. Dr. RODNEY H. TRUE	344
Our National Prosperity, Distribution of Property and Income. CHAS. A. GILCHRIST	361
Can a College Department of Education become Scientific? Professor JOSEPH K. HART	377
New Jersey's Insects. HARRY B. WEISS	385
The Historical Continuity of Science. Professor T. BRAILSFORD ROBERTSON	389
The Conservation of the Native Fauna. WALTER P. TAYLOR	399
The Progress of Science: The Control of Epidemic Diseases and the Causes of Death; William Ramsay and Raphael Meldola; Scientific Items	410

THE SCIENCE PRESS

LANCASTER, PA.

GARRISON, N. Y.

NEW YORK: SUB-STATION 84

SINGLE NUMBER, 30 CENTS

YEARLY SUBSCRIPTION, \$3.00

JUST PUBLISHED

Barber's First Course in General Science

By FREDERIC D. BARBER, Professor of Physics in the Illinois State Normal University ; MERTON L. FULLER, Lecturer on Meteorology in Bradley Polytechnic Institute ; JOHN L. PRICER, Professor of Biology in the Illinois State Normal University, and HOWARD W. ADAMS, Professor of Chemistry in the same. vii + 588 pages of text. 12mo. \$1.25.

This manual for the first year of the high school is based on the conviction that at this stage the work in science should emphasize the physical aspects and animal and plant life, with personal and community welfare the crucial point of attack.

The topics presented have chiefly to do with the school life and home life of the pupil. They are essentially projects to be solved. Being topics with which the pupil is already more or less familiar, they have real significance and meaning to him. In dealing with home and school environment the laws and principles of the physical sciences are of primary importance, moreover, physical laws and principles are fundamental to all science, therefore, they form the major portion of this course. Microorganisms, however, play so large a part in the daily life of all people that the principal facts concerning them are also presented. The main study of animal and plant life has been left to be developed as a course in general biology, or as special courses in botany and zoology.

The approach to each new topic is made from a historical point of view, thus developing a real interest in the subject. Topics not essentially important in the environment of any class, or in the environment of the community, may easily be omitted without seriously breaking the continuity of the course.

Many of the exercises are best conducted as class demonstrations while a sufficient number of them are well adapted to individual work. The apparatus is unusually inexpensive and is such as is to be found in any fairly well-equipped laboratory, or of a commercial type easily procured.

One of the strong points of the book is its scientific accuracy. Each of the authors has made definite and material contribution, so that the volume represents the carefully arranged work of specialists in physics, chemistry, meteorology, and biology. This fact will do much to place an elementary course in general science on the high plane which it deserves.

Henry Holt and Company

34 West 33rd Street
NEW YORK

6 Park Street
BOSTON

623 South Wabash Avenue
CHICAGO

THE SCIENTIFIC MONTHLY

OCTOBER, 1916

THE ORIGIN AND EVOLUTION OF LIFE UPON THE EARTH, III¹

BY HENRY FAIRFIELD OSBORN

COLUMBIA UNIVERSITY, AMERICAN MUSEUM OF NATURAL HISTORY

LECTURE I. PART IV

Contrasts between Plant and Animal Evolution—Mutation of de Vries in Plants—Resemblances between Plant and Animal Evolution—Origin of Animals—Life of Lower and Middle Cambrian Times—Adaptive Radiation of the Invertebrata—Mutation of Waagen in Molluscs.

CONTRASTS BETWEEN PLANT AND ANIMAL EVOLUTION

In their evolution, while there is a continuous specialization and differentiation of the modes of obtaining energy, plants do not attain a higher chemical stage than that observed among the bacteria and algæ, except in the parasitic forms which feed both upon the plant and animal compounds. In the energy which they derive from the soil plants continue to be closely dependent upon bacteria, because they derive their nitrogen from nitrates generated by bacteria and absorbed along with water by the roots. In their relations to the atmosphere and to sunlight the chlorophyllic organs differentiate into the marvelous variety of leaf forms, and these in turn are separated upon stems and branches which finally lead into the creation of woody tissues and the clothing of the earth with forests. Through the specialization of leaves in connection with the germ cells flowers are developed, and plants establish a marvelous series of life environment interactions, first, with the developing insect life, and finally with the developing bird life.

The main lines of the ascent and classification of plants are traced by paleobotanists partly from their structural evolution, which is

¹ Fourth course of lectures on the William Ellery Hale Foundation, National Academy of Sciences, delivered at the meeting of the academy at Washington, on April 17 and 19, 1916. The author desires to express his special acknowledgments to Dr. M. A. Howe, of the New York Botanical Garden; Professor Charles Schuchert, of Yale University; Professor Gary N. Calkins, of Columbia University and Mr. Roy W. Miner, of the American Museum of Natural History, for notes and suggestions used in the preparation of this section.

almost invariably adapted to keep their chlorophyllic organs in the sunlight² in competition with other plants; and partly from the evolution of their reproductive organs, which pass through the primitive spore stage into various forms of sexuality, with, finally, the development of the seed-habit and the dominance of the sporophyte.³ It is a striking peculiarity of plants that the locomotive powers evolve chiefly in connection with their reproductive activities, namely, with the movements of the germ cells: in this respect and in their fundamentally different sources of energy they represent the widest contrast to animal evolution. One of the most striking features of plant evolution is the development of a great variety of automatic migrating organs, especially in the seed and embryonic stages, by which they are mechanically propelled through the air or water. Plants are otherwise dependent on the motion of the atmosphere and of the water for the migration of their germs and embryos and of their adult forms into favorable conditions of environment.

In the absence of a nervous system the remarkable actions and reactions which plants exhibit to stimuli are purely of a physico-chemical nature. The interactions between different tissues of plants, which become extraordinarily complex in the higher and larger forms, are probably sustained through chemical catalysis and the circulation through the tissues of accelerating and retarding agents in the nature of enzymes or hormones. It is a very striking feature of plant development and evolution that, although entirely without the coordinating agency of a nervous system, all parts are kept in a condition of perfect correlation. This fact is consistent with the comparatively recent discovery that a large part of the coordination of animal organs and tissues which was formerly attributed to the nervous system is now known to be catalytic. Throughout the evolution of plants the fundamental distinctions between the chromatin and the protoplasm are sustained exactly as among animals.

It would appear from the researches of de Vries⁴ and other botanists that the sudden alterations of structure and function which may be known as *mutations of de Vries*⁵ are of far more general occurrence among plants than among animals. Such mutations are attributable to sudden alterations of molecular and atomic constitution. Sensitiveness to the biochemical reactions of the physical environment should theoretically be more evident in organisms like plants which derive their energy directly from inorganic compounds which are constantly changing their chemical formulæ with the conditions of moisture, of

² Wager, Harold, 1915, p. 468.

³ M. A. Howe.

⁴ de Vries, Hugo, 1901, 1903, 1905.

⁵ As distinguished from the earlier defined *Mutations of Waagen*, 332.

aridity, of temperature, of chemical soil content; than in organisms like animals which secure their food compounds ready-made by the plants and possessing comparatively similar and stable chemical formulæ. Thus a plant transferred from one environment to another exhibits much more sudden and profound changes than an animal, for the reason that all the sources of plant energy are profoundly changed while the sources of animal energy are only slightly changed. The highly varied chemical sources of plant energy are, in other words, in striking contrast with the comparatively uniform sources of animal energy which are primarily the carbohydrates and the proteins formed by the plants.

In respect to *character-origin*, therefore, plants may in accordance with the de Vries mutation hypothesis exhibit discontinuity or sudden changes of form and function more frequently than animals. In respect to *character-coordination*, or the harmonious relations of all their parts, plants are inferior to animals only in their sole dependence on catalytic enzymes; while animal characters are coordinated both through catalytic enzymes and through the nervous system. In respect to *character-velocity*, or the relative rates of movement of different parts of plants both in individual development and in evolution, plants appear to compare very closely with animals.

This law of changes in character-velocity, both in individual development (ontogeny) and in racial development (phylogeny), is one of the most mysterious and difficult to understand in the whole order of biologic evolution, for it is distinctively a chromatin phenomenon, although visible in protoplasmic form. Among plants it is illustrated by the recent observations of Coulter on the relative time of appearance of the reproductive cell organs (archegonia) in the two great groups of gymnosperms, the Cycads and the Conifers, as follows: in the Cycads, which are confined to warmer climates, the belated appearance of the archegonium persists; in the Conifers, in adaptation to colder climates and the shortened reproductive season, the appearance of the archegonium is thrust forward into the early embryonic stages. Finally, in the flowering plants (Angiosperms) the backward movement of this character continues until the third cellular stage of the embryo is reached. This is but one illustration among hundreds which might be chosen to show how character-velocity in plants follows exactly the same laws as in animals, namely, characters are accelerated or retarded in race evolution and in individual development in adaptation to the environmental and individual needs of the organism. We shall see this mysterious law beautifully illustrated among the vertebrates, where of two characters, lying side by side, one exhibits inertia, the other momentum.

THE ORIGIN OF ANIMAL LIFE

A prime biochemical characteristic in the origin of animal life is the derivation of energy neither directly from the water, from the earth, nor from the earth's or sun's heat, as in the most primitive bacterial stages; nor from sunshine, as in the chlorophyllic stage of plant life; but from its stored form in the bacterial and plant world.

We have no idea when the first unicellular animals known as protozoa appeared. Since the protozoa feed freely upon bacteria it is possible they may have evolved during the bacterial epoch; it is known that protozoa are at present one of the limiting factors of bacterial activity in the soil and it is even claimed⁶ that they have a material effect on the fertility of the soil through the consumption of nitrifying bacteria.

On the other hand, it may be that the protozoa appeared during the algal epoch or subsequent to the chlorophyllic plant organisms which now form the primary food supply of the freely floating and swimming protozoan types. A great number of primitive flagellates are saprophytic, using only dissolved proteids as food.⁷

Apart from the parasitic mode of deriving their energy, even the lowest forms of animal life are distinguished both in the embryonic and adult stages by their locomotive powers. Heliotropic or sun reactions, or movements towards sunlight, are manifested at an early stage of animal evolution. In this function there appear to be no boundaries between animals and the embryos of plants.⁸ As cited by Loeb and Wasteneys, Paul Bert in 1869 discovered that *Daphnia* swims towards the light in all parts of the visible spectrum, but most rapidly in the yellow or in the green. More definitely, Loeb observes that there are two particular regions of the spectrum, the rays of which are especially effective in causing organisms to turn, or to congregate, towards them: these regions lie (1) in the blue, in the neighborhood of a wave-length of $477\ \mu\mu$, and (2) in the yellowish-green, in the region of $\lambda = 534\ \mu\mu$; and these two wave-lengths affect different organisms, with no very evident relation to the nature of these latter. Thus the blue rays (of $477\ \mu\mu$) attract the protozoan infusorian *Euglena*, the hydroid cœlenterate *Eudendrium*, and the seedlings of oats; while the yellowish-green rays (of $534\ \mu\mu$) in turn affect the protozoan *Chlamydomonas*, the little water-flea *Daphnia* (crustacean), and the larvæ of barnacles (crustacea).

Aside from these heliotropic movements which they share with plants, animals show higher powers of individuality, of initiation, of

⁶ Russell, Edward John, and Hutchinson, Henry Brougham, 1909, p. 118; 1913, pp. 191, 219.

⁷ G. N. Calkins.

⁸ Loeb, Jacques, and Wasteneys, Hardolph, 1915. 1, pp. 44-47; 1915. 2, pp. 328-330.

experiment, and of what Jennings cautiously terms "a conscious aspect of behavior." In his remarkable studies this author traces the genesis of animal behavior to reaction and trial. Thus the behavior of organisms is of such a character as to provide for its own development. Through the principle of the production of varied movements and that of the resolution of one physiological state into another, anything that is possible is tried and anything that turns out to be advantageous is held and made permanent.⁹ Thus the sub-psychic stages when they evolve into the higher stages give us the rudiments of discrimination, of choice, of attention, of desire for food, of sensitiveness to pain, and also give us the foundation of the psychic properties of habit, of memory and of consciousness.¹⁰ These profound and extremely ancient powers of animal life exert a constant *creative influence* on animal form, whether we adopt the Lamarckian or Darwinian explanation of the origin of animal form, or find elements of truth in both explanations.¹¹ Less cautious observers than Jennings¹² find in the Foraminifera the rudiments of the highest functions and the most intelligent behavior of which undifferentiated protoplasm has been found capable.

In the evolution of the Protozoa¹³ the starting point is a simple cell consisting of a small mass of protoplasm containing a nucleus. This passes into the plasmodial condition of the Rhizopods, in which the protoplasm increases enormously to form the relatively large, unprotected masses adapted to the creeping or semi-terrestrial mode of life. From these evolve the forms specialized for the floating pelagic habit, namely, the Foraminifera and Radiolaria, protected by an excessive development and elaboration of their skeletal structures.¹⁴ In the Mastigophora the body develops flagellate organs of locomotion and food-capture. As an offshoot from the ancestors of these forms arose the Ciliata, the most highly organized unicellular types of living beings, for a Ciliate like every other protozoan is a complete and independent organism and is specialized for each and all of the vital functions performed by the higher multicellular organisms as a whole.

In the chemical life of the Protozoa¹⁵ (*Amœba*) the protoplasm is made up of colloidal and of crystalloidal substances of different density, between which there is a constant, orderly, chemical activity. The relative speed of these orderly processes is due to specific catalyzers which control each successive step in the long chain of chemical actions. Thus in the breaking down process (destructive metabolism) the by-

⁹ Jennings, H. S., 1906, pp. 318, 319.

¹⁰ *Op. cit.*, pp. 329-335.

¹¹ These rival theories are fully explained below in the introduction to the second lecture.

¹² Heron-Allen, Edward, 1915, p. 270.

¹³ Minchin, E. A., 1916, p. 277.

¹⁴ *Op. cit.*, p. 278.

¹⁵ Calkins, Gary N., 1916, p. 260.

products act as poisons to other organisms or they may play an important part in the vital activities of the organism itself, as in the phosphorescence of *Noctiluca*, or as in reproduction and regeneration. Since regrowth or regeneration¹⁶ takes place in artificially separated fragments of cells in which the nuclear substance (chromatin) is believed to be absent, the formation of new parts may be due to a specific enzyme, or perhaps to some chemical body analogous to hormones and formed as a result of mutual interaction of the nucleus and the protoplasm. Reproduction through cell-division is also interpreted theoretically as due to action set up by enzymes or other chemical bodies produced as a result of interaction of nucleus and cell body. The



FIG. 1. THE WORLD IN LATE LOWER CAMBRIAN (WAUCOBIAN OR OLENELLUS) TIME. After Schuchert.

protoplasm is regenerated, including both the nuclei and the cell plasm, by the distribution of large quantities of nucleo-proteins, the specific chemical substance of chromatin.

Through this modern chemical interpretation of the Protozoan life cycle we may conceive how the three laws of thermodynamics may be applied to single-celled organisms, and especially our fundamental biologic law of action, reaction and interaction. By far the most difficult problem in biologic evolution is the working of this law among the many-celled organisms (Metazoa) including both invertebrates and vertebrates.

During the long period of pre-Cambrian time, which is estimated at not less than thirty million years from the actual thickness of the

¹⁶ *Op. cit.*, pp. 261-264, 266.

Canadian pre-Cambrian rocks, some of the simpler protozoa gave rise to the next higher stage of animal evolution and to the adaptive radiation on land and sea of the Invertebrata. We are compelled to assume that the *physico-chemical actions, reactions and interactions* were sustained and rendered step by step more complex as the single cells passed into groups of cells, and these into organisms with two chief cell layers (Coelenterata), and finally into organisms with three chief cell layers.

The metamorphosis of the pre-Cambrian rocks has for the most part concealed or destroyed all the life impressions which were undoubtedly made in the various continental or oceanic basins of sedimentation. Indirect evidences of the long process of life evolution are found in the great accumulations of limestone, and in the deposits of iron and graphite¹⁷ which, as we have already observed, constitute certain proofs of the existence at enormously remote periods of limestone-forming algæ, of iron-forming bacteria and of a variety of chlorophyll-bearing plants. These evidences begin with the metamorphosed sedimentaries overlying the basal rocks of the primal earth's crust. The discovery by Walcott¹⁸ of the highly specialized and differentiated invertebrates of the Middle Cambrian seas completely confirms the prophecy made by Charles Darwin in 1859¹⁹ as to the great duration of pre-Cambrian time.

By Middle Cambrian time the adaptive radiation of the Invertebrata to all the conditions of life—in continental waters, along the shore lines, and in the littoral and pelagic environment of the seas—was governed by mechanical and chemical principles fundamentally similar to those observed among the protozoa, but distributed through myriads of cells and highly complicated tissues and organs, instead of being differentiated within a single cell as in the ciliate protozoa. Among the principal functions thus evolved were, first, a more complicated action, reaction and interaction with the environment and within the organism; second, a more efficient locomotion in the quest of food, in the capture of food and in the escape from enemies, giving rise in some cases to skeletal structures of various types; third, offensive and defensive armature and weapons, including chemical modes of offence and defence and methods of burrowing.²⁰ There are also protective coverings for sessile animals.

We find swiftly moving types with the lines of modern submarines, whose mechanical means of propulsion resemble those of the most primitive darting fishes (*e. g.*, *Sagitta* and other chaetognaths). Other

¹⁷ Barrell, Joseph. See Pirsson, Louis V., and Schuchert, Charles, 1915, p. 547.

¹⁸ Walcott, Charles D., 1911, 1912.

¹⁹ Darwin, Charles, 1859, pp. 306, 307.

²⁰ R. W. Miner.

types like the Crustacea have armature for the triple purposes of defence, offence, and locomotion; they are adapted to less swift motion and include the slowly-moving, bottom-living, armored types of trilobites. Then there are slowly moving fixed forms, such as the brachiopods and gastropods, with very dense armature of phosphate and carbonate of lime. Finally, there are pelagic or floating types such as the jelly fishes which are chemically protected by the poisonous secretions of their "sting-cells."

There is abundant evidence that in pre-Cambrian time certain of the invertebrates had already passed through primary, secondary, and even tertiary phases of adaptation.

Our first actual knowledge of such adaptations dates back to the pre-Cambrian and is afforded by Walcott's discovery²¹ in the Greyson shales of the Algonkian Belt Series of fragmentary remains of that problematic fossil, *Beltina danai*, which he refers to the Merestomata and near to the Eurypterids, thus making it probable that either Eurypterids, or forms ancestral both to trilobites and Eurypterids existed in pre-Cambrian times. More extensive adaptive radiations are found in the Lower Cambrian life zone of *Olenellus*, a compound phase of trilobite evolution representing the highest trilobite development. These animals are beautifully preserved as fossils because of their dense chitinous armature which protected them and at the same time admitted of considerable freedom of motion. The relationships of these

animals have long been in dispute, but the discovery of the ventral surface and appendages in the Mid-Cambrian *Neolenus serratus* seems to place the trilobites definitely as a sub-class of the Crustacea, with affinities to the existing freely swimming, pelagic phyllopo



FIG. 2. A MID-CAMBRIAN TRILOBITE, *Neolenus serratus* (ROMINGER). After Walcott.

changed generically to the present time, namely, for a period of nearly thirty million years. These animals afford a classic illustration of the rather exceptional condition known to evolutionists as "balance," resulting in absolute stability of type. One example is found in *Lingulella* (*Lingula*), of which the fossil form, *Lingulella acuminata*, characteristic of Cambrian and Ordovician times, is closely similar to

²¹ Walcott, Charles D., 1899, pp. 235-244.

that of *Lingula anatina*, a species living to-day. Representatives of the genus *Lingula* (*Lingulella*) have persisted from Cambrian to recent times. The great antiquity of the Brachiopods as a group is well illustrated by the persistence of *Lingula* (Cambrian—Ordovician—Recent), on the one hand, and of *Terebratula* (Devonian—Recent), belonging to a widely differing family, on the other. These lamp-shells are thus characteristic of all geologic ages, including the present. Reaching their maximum radiation during the Ordovician and Silurian, they gradually lost their importance during the Devonian and Permian, and at the present time have dwindled into a relatively insignificant group, members of which range from the oceanic shore-line to the deep-sea or abyssal habitat.



FIG. 3. BRACHIOPODS, CAMBRIAN AND RECENT. *Lingulella* (*Lingula*) *acuminata*, ranging from Cambrian to Ordovician, and the very similar *Lingula anatina*, persisting from Cambrian times down to the present day. *Lingulella*, Cambrian to Ordovician, contrasted with the widely differing *Terebratula* which ranges from Devonian to recent times.

By the Middle Cambrian the continental seas covered the whole region of the present Cordilleras of the Pacific coast. In the present region of Mount Stephen, B. C., in the unusually favorable marine oily shales of the Burgess formation, the remarkable evolution of invertebrate life prior to Cambrian time has been revealed through Walcott's epoch-making discoveries between 1909 and 1912.²² It is at once evident (Figs. 2-9) that the seashore and pelagic life of this time exhibits types as widely divergent as those which now occur among the aquatic Invertebrata. Not only are the characteristic external features of these soft-bodied invertebrates evident in the fossil remains, but in some cases even the internal organs show through the imprint of the

²² Walcott, Charles D., 1911, 1912.

transparent integument. Walcott's researches on this superb series have brought out two important points: first, the great antiquity of the chief invertebrate groups and their high degree of specialization in Early Cambrian times, which makes it necessary to look for their origin far back in the pre-Cambrian ages; and, second, the extraordinary per-

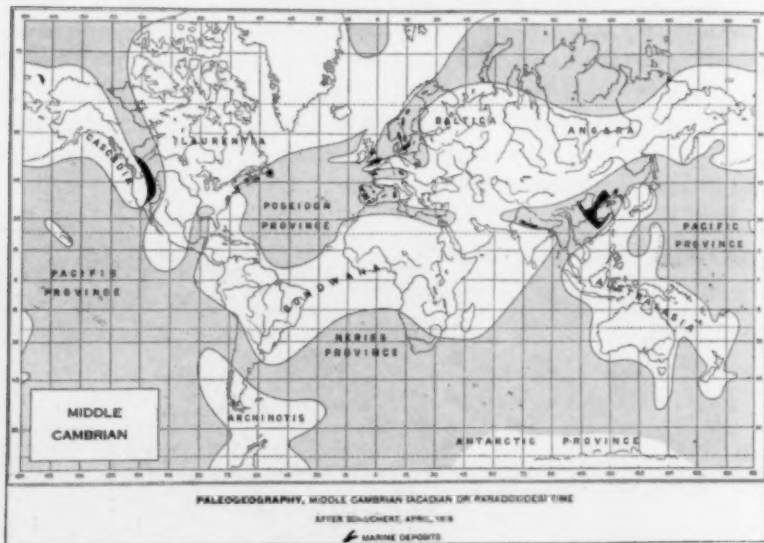


FIG. 4. THE WORLD IN MIDDLE CAMBRIAN (ACADIAN OR PARADOXIDES) TIME. After Schuchert.

sistence of type among members of all the invertebrate phyla from the Mid-Cambrian to the present time, so that sea-forms with an antiquity of 25 million years can be placed side by side with existing sea-forms with very obvious similarities of function and structure as in the series arranged for these lectures by Mr. Roy W. Miner, of the American Museum of Natural History.

Except for the trilobites, the existence of Crustacea in Cambrian times was unknown until the discovery of the primitive shrimp-like form, *Burgessia bella* (Fig. 5), a true crustacean, which may be compared with *Apus lucasanus*, a member of the most nearly allied recent group. We observe a close correspondence in the shape of the chitinous shield (carapace), in the arrangement of the leaf-like locomotor appendages at the base of the tail, and in the clear internal impressions in *Burgessia* of the so-called "kidneys" with their branched tubules. The position of these organs in *Apus* is indicated by the two light areas on the carapace. Other specimens of *Burgessia* found by Walcott show that the tapering abdominal region and tail are jointed as in *Apus*.

The age of the armored merostome arthropods is also thrust back to Mid-Cambrian times by the discovery of several genera of Glas-

pidæ, the typical species of which, *Molaria spinifera* Walcott, may be compared with that "living fossil" the horseshoe crab (*Limulus polyphemus*), its nearest modern relative, which is believed to be not so closely related to the phyllopod crustaceans as would at first appear, but rather to the Arachnida through the Eurypterids and scorpions. *Molaria* and *Limulus* are strikingly similar in their cephalic shield, segmentation, and telson; but the latter shows an advance upon the earlier type in the coalescence of the abdominal segments into a single abdominal shield-plate. The trilobate character of the cephalic shield in *Molaria* is an indication of its trilobite affinities; hence we apparently have good reason to refer both the merostomes and phyllopods to an ancestral trilobite stock.

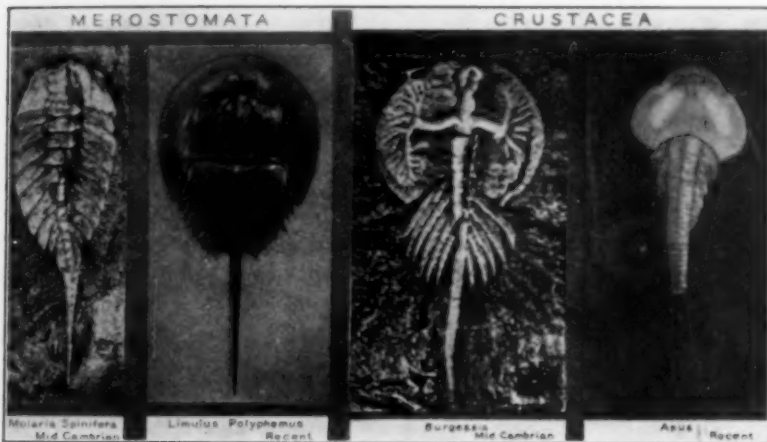


FIG. 5. SHRIMP AND HORSE-SHOE CRAB OF THE CAMBRIAN. *Burgessia bella*, a shrimp-like crustacean of the Middle Cambrian (after Walcott) compared with the very similar *Apus lucasani* of recent times; and *Molaria spinifera*, a Mid-Cambrian merostome (after Walcott) compared with the "horse-shoe crab," *Limulus polyphemus*.

Another mode of defence is presented by the sessile, rock-clinging sea-cucumbers (Holothuroidea) protected by their leathery epidermis in which are scattered a number of calcareous plates, as among certain members of the modern edentate mammals. Fossils of this group have been known heretofore only through scattered spicules and calcareous plates dating back no earlier than Carboniferous times (Goodrich); therefore Walcott's holothurian material from the Cambrian constitutes new records for invertebrate paleontology, not only for the preservation of the soft parts, but for the great antiquity of these Cambrian strata. In *Louisella pedunculata* (Fig. 6) we observe the preservation of a double row of tube-feet, and the indication at the top of oral tentacles around the mouth like those of the modern Elpidiidae. A typical rock-clinging holothurian is the recent *Pentacta frondosa*.

Beside these sessile, rock-clinging forms, the adaptive radiation of the holothurians developed burrowing or fossorial types, an example of which is the Mid-Cambrian *Mackenzia costalis* (Fig. 6) which strikingly suggests one of the existing burrowing sea-cucumbers, *Synapta*

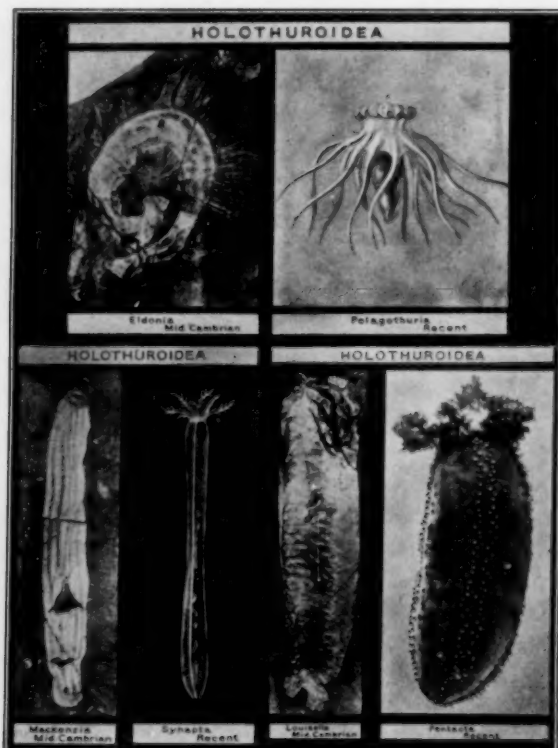


FIG. 6. SEA-CUCUMBERS AND JELLY FISH OF THE CAMBRIAN. *Eldonia ludwigi* of the Middle Cambrian (after Walcott), regarded as pelagic, strongly resembles the jelly fish. *Pelagothuria natatrix*, thought to be an analogous form, shows wide differences. The mouth of *Pelagothuria* is above the swimming umbrella, the posterior part of the body and the anal opening are below: in the fossil *Eldonia* both mouth and anus hang below. *Mackenzia costalis*, a Mid-Cambrian form (after Walcott) strongly resembling the burrowing sea-cucumbers, one form of which, *Synapta girardii*, is shown at the right. *Louisella pedunculata*, another Mid-Cambrian form (after Walcott), and a recent rock-clinging form, *Pentacta frondosa*.

girardii. The characteristic elongated cylindrical body-form with longitudinal muscle-bands is clearly preserved in the fossil, while around the mouth is a ring of tubercles interpreted by Walcott as calcareous ossicles from above which the oral tentacles have been torn away.

A remarkable and problematic Mid-Cambrian fossil, *Eldonia ludwigi* (Fig. 6), is regarded by Walcott as a free-swimming or pelagic animal. It bears a superficial resemblance to a medusa or jelly fish, while the lines radiating from a central ring suggest the existence of

a water vascular system; but the cylindrical body coiled around the center shows a spiral intestine through its transparent body-wall, and it is therefore considered to be a swimming holothurian or sea-cucumber with a medusa-like umbrella. The existing holothuroid *Pelagothuria natatix* Ludwig, shown at the right, is somewhat analogous although it also displays wide differences of structure. If *Eldonia ludwigi* proves to be a holothurian we witness in Mid-Cambrian strata members of this order differentiated into at least three widely distinct families.

The worms, including swimming and burrowing annulates, are represented in the Burgess fauna by a very large number of specimens, com-

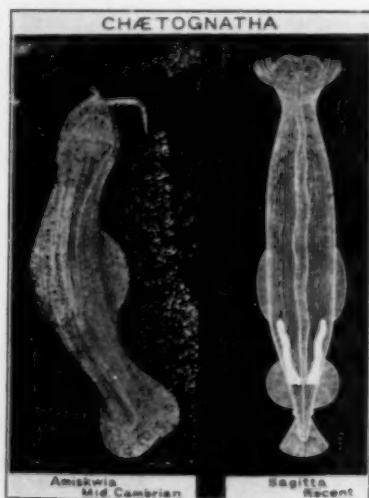


FIG. 8. FREELY SWIMMING CHÆTOGNATHS. *Amiskwia sagittiformis*, a Mid-Cambrian form (after Walcott), has a body divided into head, trunk and tail like the recent *Sagitta*, as seen in *S. gardineri*.

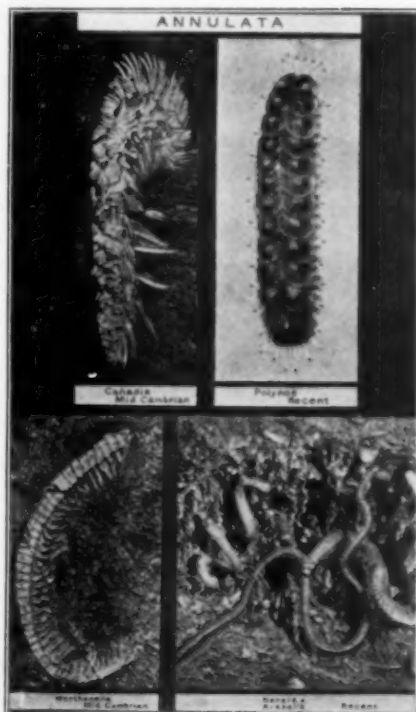


FIG. 7. WORMS (Annulata) OF THE MIDDLE CAMBRIAN. *Canadia spinosa*, a Mid-Cambrian form (after Walcott) with overlapping groups of scale-like dorsal spines, resembling those of the living *Aphroditide*, such as *Polynoe squamata* *Worthenella Cambria* a worm of Mid-Cambrian times (after Walcott) compared with *Nereis virens* and *Arabella opalina*, recent marine worms.

prising nineteen species, distributed through eleven genera and six families. Most of these are of the order Polychæta, as, for example, *Worthenella cambria*, in which the head is armed with tentacles, while the segmented body and the continuous series of bilobed parapodia are very clear. When compared with such typical living polychætes as *Nereis virens* and *Arabella opalina* (Fig. 7), we have clear proof of the modern relationships of these Mid-Cambrian species, as well as of Cam-

brian sea-shore and tidal conditions closely similar to those of the present time. A specialization toward the spiny or scaly annulates at this period is emphasized in such forms as *Canadia spinosa* (Fig. 7), a slowly-moving form which shows a development of lateral chetæ and overlapping groups of scale-like dorsal spines comparable only to those of the living Aphroditidæ. An example of this latter family is *Polynoe squamata*, furnished with dorsal scales. Still other recent forms, such as *Palmyra aurifera* Savigny, have groups of spinous scales closely resembling those of *Canadia*.

Even the modern freely propelled *Chætognatha* have their representatives in the Mid-Cambrian, for to no other group of invertebrates

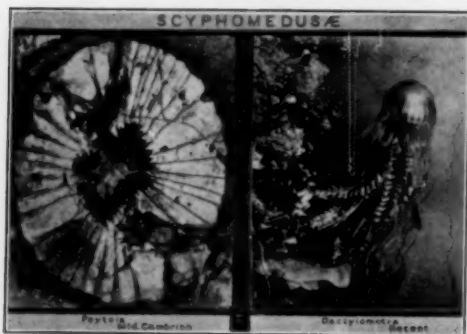


FIG. 9. JELLY FISH (*Scyphomedusæ*) OF THE CAMBRIAN. *Peytoia nathorsti*, Mid-Cambrian (after Walcott), and *Dactylometra quinquecirra*, recent. The thirty-two lobes of the fossil specimen correspond with the same number often observed in *Dactylometra*, and the characteristic marginal tentacles may have been lost in *Peytoia*.

can *Amiskwia sagittiformis* Walcott (Fig. 8) be referred, so far as we can judge by its external form. As in the recent *Sagitta* the body is divided into head, trunk, and a somewhat fish-like tail. Its single pair of fins of chætognath type would perhaps give a clearer affinity to the genus *Spadella*. The conspicuous pair of tentacles which surmounts the head is absent in modern chætognaths, although some recent species show a pair of sensory

papillæ mounted on a stalk on either side of the head as in *Spadella cephaloptera* Bush. The digestive canal and other digestive organs appear through the thin walls of the body.

A modern group of jelly fishes, the *Scyphomedusæ* (Fig. 9), is represented by the Middle Cambrian *Peytoia nathorsti* the elliptical disc of which is seen from below. Although this fossil species is ascribed by Walcott to the group *Rhizostomæ* because of a lack of marginal tentacles, the thirty-two radiating lobes which are so beautifully preserved in the fossil correspond closely with those of the existing genus *Dactylometra*. It is possible that the marginal tentacles may have been lost in *Peytoia*, as so frequently happens in living jelly fishes when in a dying condition.

PHYLA OF FOSSIL INVERTEBRATA

Protozoa,
Coelenterata,
Molluscoida,

Echinodermata,
Annulata,
Arthropoda,
Mollusca.

From the Burgess fauna it appears that the invertebrates had entered all the life zones of the continental and oceanic waters except possibly the abyssal. All the principal phyla—the segmented Annu-
lata, the joined Arthropoda (including trilobites, merostomes, crus-

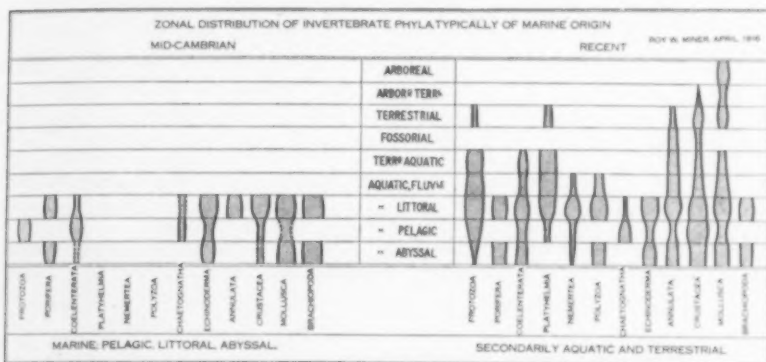


FIG. 10. LIFE ZONES OF CAMBRIAN AND RELATED EXISTING INVERTEBRATES. Chart showing the contrast between the Mid-Cambrian (left) and recent (right) phyla of the Invertebrata. By Roy W. Miner.

taceans, arachnids, and insects), medusæ and other coelenterates, echi-
nodermes, brachiopods, molluscs (including pelycypods, gastropods, am-
monites and other cephalopods), and sponges—were all clearly estab-
lished in pre-Cambrian times. Which one of these great invertebrate

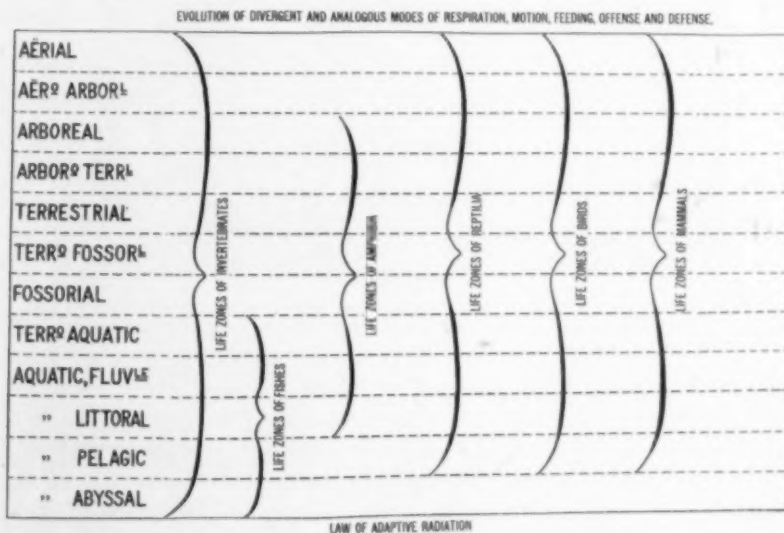


FIG. 11. LIFE ZONES OF INVERTEBRATES, COMPARED WITH THOSE OF FISHES, AMPHIBIANS, REPTILES, BIRDS AND MAMMALS. Chart showing the extension of vertebrates and invertebrates throughout the various habitat zones.

divisions gave rise to the vertebrates remains to be determined by future discovery. At present the Annulata, Arthropoda, and Echinodermata all have their advocates as being theoretically related to the ancestors of the vertebrates. The evolution of each of these invertebrate types follows the laws of adaptive radiation and in the case of the articulates, molluscs, and molluscoids extends into the terrestrial and arboreal habitat zones, while many branches of the articulates enter the aerial zone.

The evolution of the articulates²³ is believed to be as follows: From a pre-Cambrian Annelidan (worm-like) stock, arose the trilobites with their chitinous armature and many-jointed bodies. The same stock gave rise also to the chitin-armored sea-scorpions or Eurypterids which attained a great size and dominated the seas of Silurian times (Fig. 14). Another line from the same stock is that of the chitin-armored horseshoe crab (*Limulus*). Out of the Eurypterid stock of Silurian

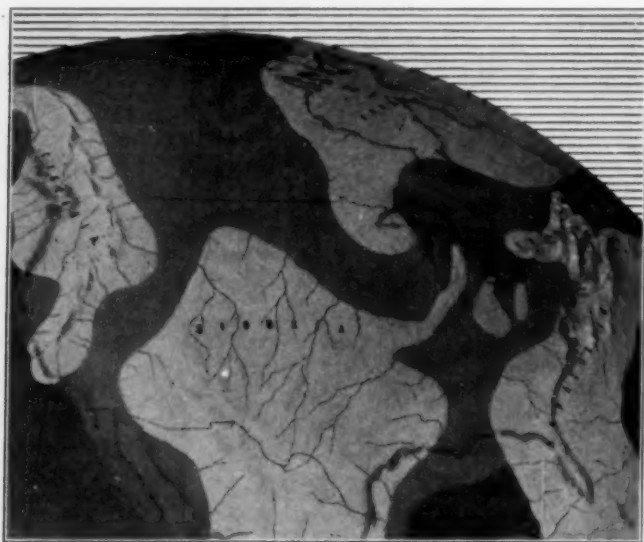


FIG. 12. NORTH AMERICA IN MIDDLE DEVONIAN (HAMILTON) TIME. Detail from globe model by Chester A. Reeds and George Robertson after Schuchert.

times may have come the terrestrial scorpions, fossils of which are first known in the Silurian, and through it arose the entire group of arachnoid (spider-like) animals, including the existing scorpions, spiders, and mites. It is also possible that the amphibious, terrestrial, and aerial Insecta were derived from some Silurian or Devonian chitin-armored articulate. The true Crustacea also have probably developed out of the same pre-Cambrian stock, giving rise to the phyllopods and

²³ Pirsson, Louis V., and Schuchert, Charles, 1915, p. 608.

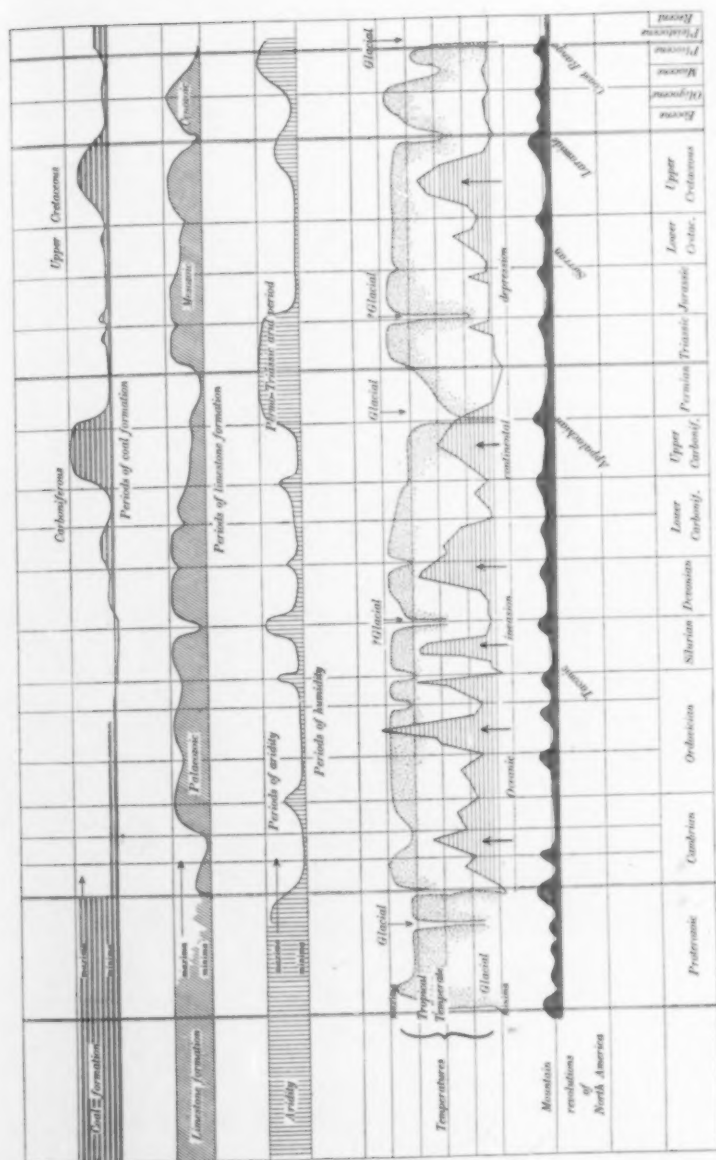


FIG. 13. CORRELATION OF CLIMATIC, CONTINENTAL, OCEANIC AND LIFE PHASES modified from Huntington after Schuchert, showing the maximum and minimum periods of coal formation, of limestone formation, of aridity and of humidity, and also five theoretic epochs of glaciation in the northern and southern hemispheres, seven periods of maximum continental depression and oceanic invasion, and six periods of mountain revolution.

other true Crustacea of the Cambrian, and to the cirripedes or barnacles of the Ordovician.

Schuchert observes that there is no more significant period in the history of the world than the Devonian²⁴ (Fig. 12) for at this time the increasing verdure of the land invited the invasion of life from the waters, the first conquest of the terrestrial environment being attained

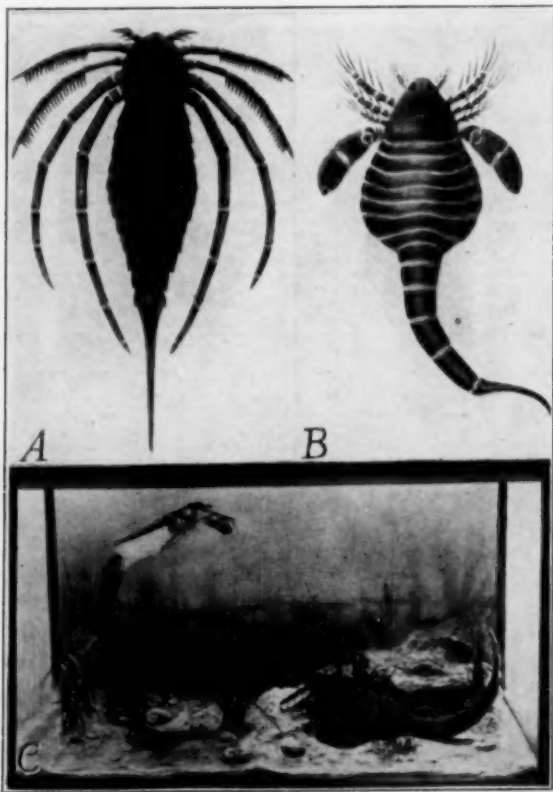


FIG. 14. A. RESTORATION OF *Stylonurus excelsior*, CATSKILL SANDSTONE. Natural length, four feet. B. Restoration of *Eusarcus*, Bertie waterlime. Natural length, three feet. C. Restoration of the Silurian eurypterid *Eusarcus*, age of the Bertie waterlime. After John M. Clarke.

by the scorpions, shell fish, worms and insects. This is an instance of the constant dispersion of animal forms into new environments for their food supply, the chief instinctive cause of all migration. This impulse is constantly acting and reacting throughout geologic time with the migration of the environment, graphically presented by Huntington's chart from the researches of Barrell, Schuchert, and others (Fig. 13, Huntington's chart). The periodic readjustment of the

²⁴ Pirsson, Louis V., and Schuchert, Charles, 1915, p. 714.

earth crust of North America²⁵ is witnessed in fourteen periods of mountain-making of varying importance. Between these relatively short periods of upheaval came²⁶ periods when the continent was more or less flooded by the oceans. There are certainly twelve and probably not less than seventeen periods of continental flooding which vary in extent up to the submergence of four million square miles of surface. Each of these changes, which by some geologists are believed to be cyclic, included long epochs especially favorable to certain forms of life, resulting in the majority of cases in high specialization like that of the sea-scorpions (Eurypterids) followed by more or less sudden extinction.

Changes of environment play so large and conspicuous a part in the selection and elimination of the invertebrates that the assertion is often made that environment is the cause of evolution, a statement directly contrary to our fundamental biologic law that the cause of evolution lies within the four complexes of action, reaction and interaction (see p. 10). Perrin Smith, who has made a most exhaustive analysis of the evolution of the cephalopod molluscs and especially of the Triassic ammonites, observes that the evolution of form continues uninterruptedly even where there is no evidence whatever of environmental change.

It was in the ammonites that Waagen first observed the actual mode of transformation of one animal form into another, set forth in his classic paper of 1869, "Die Formenreihe des *Ammonites subradiatus*."²⁷ The essential feature of the "mutation of Waagen"²⁸ is that it established the law of minute and inconspicuous changes of form which accumulate so gradually that they are observable only after a

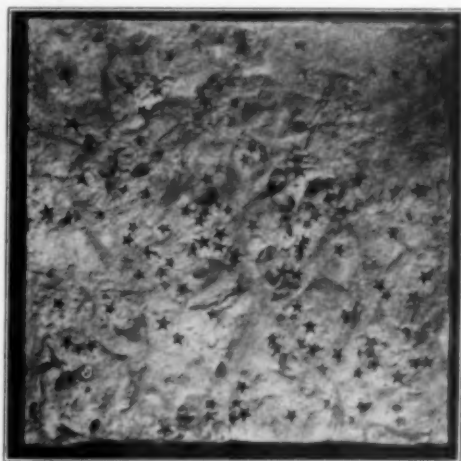


FIG. 15. A FOSSIL STAR-FISH OF DEVONIAN TIMES, ASSOCIATED WITH AND DEVOURING BIVALVES. Hamilton group, Saugerties, New York. After John M. Clarke.

²⁵ Pirsson, Louis V., and Schuchert, Charles, 1915, p. 979.

²⁶ *Op. cit.*, p. 982.

²⁷ Waagen, W., 1869.

²⁸ The term "mutation" was introduced by Waagen in 1869. Twenty years later the great Austrian paleontologist, Neumayr, defined the "Mutationsrichtung" as the tendency of form to evolve in certain definite directions. See Neumayr, M., 1889, pp. 60, 61.

considerable passage of time; they take a definite direction (*Mutationsrichtung*) and represent a true evolution of the chromatin. This law of definitely directed evolution is illustrated in the detailed structure of the type series of ammonites (Fig. 16) in which Waagen's discovery was made. It has proved to be a fundamental law of the evolu-

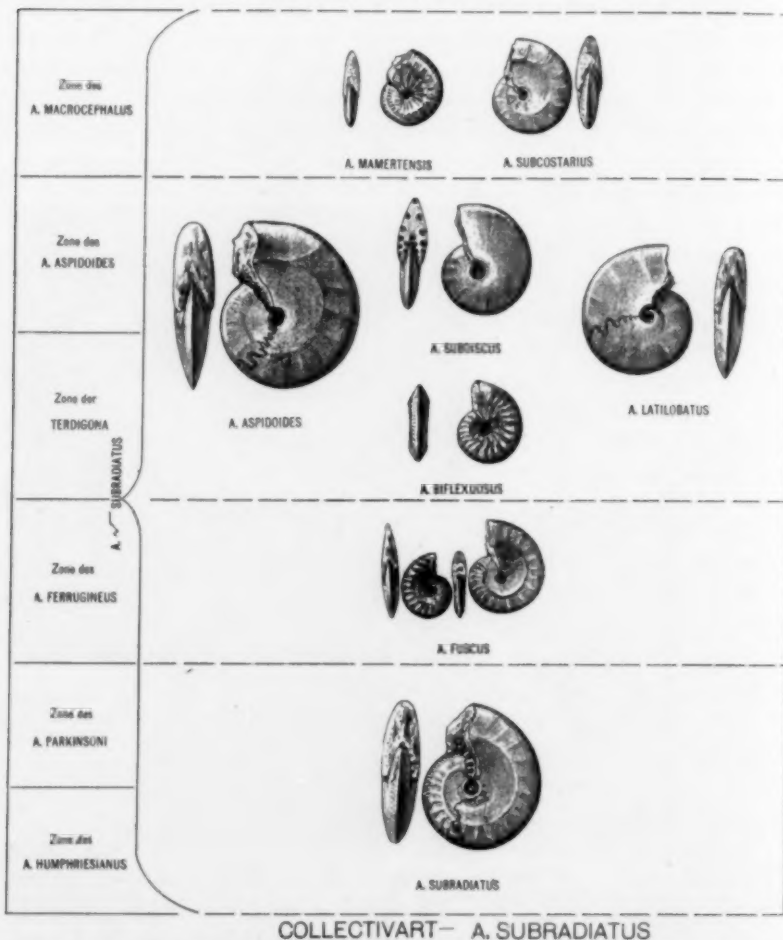


FIG. 16. THE TYPE SERIES OF THE MUTATIONS OF WAAGEN (1869) IN AMMONITES. Successive mutations of *Ammonites subradiatus* drawn and rearranged from the original plates of Waagen.

tion of form, for it is observed alike in invertebrates and vertebrates wherever a closely successive series can be obtained. In the invertebrates a mutation series of the brachiopod, *Spirifer mucronatus* of the Middle Devonian or Hamilton time, is one of the most typical (Fig. 17). The essential principle of Waagen's discovery, which is one of the most important in the whole history of biology, is that certain new char-

acters arise definitely and continuously, and, as Osborn has subsequently shown, adaptively.²⁹ It is unfortunate that the same term, "mutation," was chosen by de Vries to express his observation that

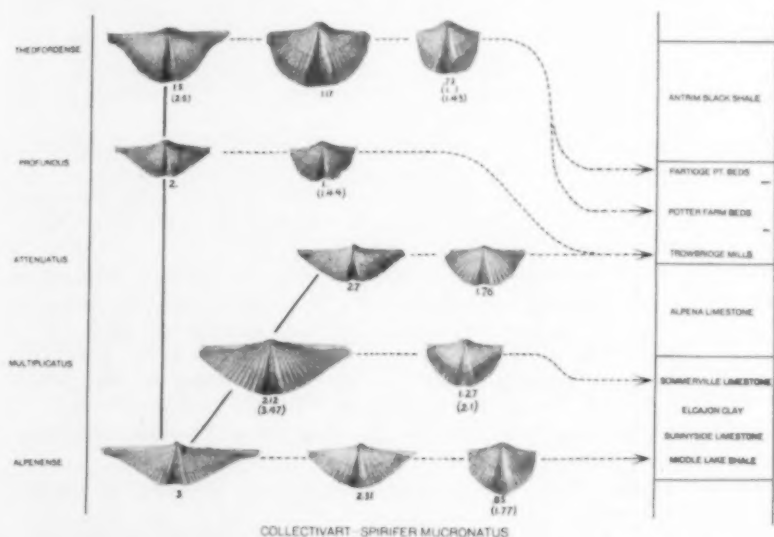


FIG. 17. SUCCESSIVE MUTATIONS OF *Spirifer mucronatus*. Specimens from the Alpena section arranged by Grabau. In the scale of strata at the right $8\frac{1}{4}$ mm. = 100 ft. depth.

certain characters in plants arise discontinuously through changes in the chromatin and without any definite direction or adaptive trend. The essential feature of de Vries's observations, in contrast to Waagen's, is that of discontinuous saltations either in indefinite or non-adaptive directions.

(To be continued)

LIST OF WORKS CITED

- Calkins, Gary N., 1916. General Biology of the Protozoan Life Cycle. *Amer. Naturalist*, Vol. L., No. 593, May, 1916, pp. 257-270.
- Darwin, Charles, 1859. On the Origin of Species, by Means of Natural Selection; or the Preservation of Favoured Races in the Struggle for Life. London, 1859.
- Heron-Allen, Edward, 1915. Contributions to the Study of the Bionomics and Reproductive Processes of the Foraminifera. *Phil. Trans.*, Vol. CCVI., B. 329, June 23, 1915, pp. 227-279.
- Hutchinson, Henry Brougham (with Russell, Edward John), 1909. The Effect of Partial Sterilization of Soil on the Production of Plant Food. *Introd. and Part I.* See Russell, 1909. 1913. *Part II.* See Russell, 1913.
- Jennings, H. S., 1906. Behavior of the Lower Organisms. New York, 1906.
- ²⁹ Osborn, Henry Fairfield, 1912.

- Loeb, Jacques (with Wasteneys, Hardolph), 1915.1. On the Identity of Heliotropism in Animals and Plants. *Proc. National Acad. Sci.*, January, 1915, pp. 44-47.
- (with Wasteneys, Hardolph), 1915.2. The Identity of Heliotropism in Animals and Plants. Second Note. *Science*, February 26, 1915, pp. 328-330.
- Minchin, E. A., 1916. The Evolution of the Cell. *Amer. Naturalist*, January, 1916, pp. 5-38; February, 1916, pp. 106-118; May, 1916, pp. 271-283.
- Neumayr, M., 1889. Die Stämme des Tierreiches. Bd. I., Wirbellose Tiere. Vienna and Prague, 1889.
- Osborn, Henry Fairfield, 1912. Tetraplasy, the Law of the Four Inseparable Factors of Evolution. *Jour. Acad. Nat. Sci. Phila.*, Vol. XV., 2d ser. Special volume. Published in Commemoration of the One Hundredth Anniversary of the Founding of the Academy, March 21, 1912. Issued September 14, 1912, pp. 275-309.
- Pirsson, Louis V. (with Schuchert, Charles), 1915. A Text-book of Geology. Part I., Physical Geology, by Louis V. Pirsson. Part II., Historical Geology, by Charles Schuchert. New York and London, 1915.
- Russell, Edward John (with Hutchinson, Henry Brougham), 1909. The Effect of Partial Sterilization of Soil on the Production of Plant Food. Introd. and Part I. *Jour. Agric. Sci.*, October, 1909, pp. 111-144.
- (with Hutchinson, Henry Brougham), 1913. Part II. *Jour. Agric. Sci.*, March, 1913, pp. 152-221.
- Schuchert, Charles (with Pirsson, Louis V.), 1915. A Text-book of Geology. See Pirsson.
- de Vries, Hugo, 1901. Die Mutationstheorie. Vol. I. Leipzig, 1901.
1903. Die Mutationstheorie. Vol. II. Leipzig, 1903.
1905. Species and Varieties, Their Origin by Mutation. Chicago and London, 1905.
- Waagen, W., 1869. Die Formenreihe des *Ammonites subradiatus*, Versuch einer paläontologischen Monographie. Geognostisch-paläontologische Beiträge, herausgegeben . . . von Dr. E. W. Benecke, Bd. II., pp. 179-257 (Heft II., S. 78). Munich, 1869.
- Wager, Harold, 1915. Behaviour of Plants in Response to the Light. *Nature*, December 23, 1915, pp. 468-472.
- Walcott, Charles D., 1899. Pre-Cambrian Fossiliferous Formations. *Bull. Geol. Soc. Amer.*, April 6, 1899, pp. 199-244.
1911. Cambrian Geology and Paleontology. II. Middle Cambrian Annelids. *Smithsonian Miscell. Colls.*, Vol. 57, No. 5, September 4, 1911, pp. 109-144.
1912. Cambrian Geology and Paleontology. II. Middle Cambrian Branchiopoda, Malacostraca, Trilobita and Merostomata. *Smithsonian Miscell. Colls.*, Vol. 57, No. 6, March 13, 1912, pp. 145-228.
- Wasteneys, Hardolph (with Loeb, Jacques, 1915.1. On the Identity of Heliotropism in Animals and Plants. See Loeb.
- (with Loeb, Jacques), 1915.2. The Identity of Heliotropism in Animals and Plants. Second Note. See Loeb.

THE DEVELOPMENT OF FOLK-TALES AND MYTHS¹

BY DR. FRANZ BOAS

COLUMBIA UNIVERSITY

THE collections of folk-tales and myths of all continents, but particularly of North America, that have been accumulated during the last few decades, have yielded the definite result that the incidents of tales have a very wide distribution, that they have been carried from tribe to tribe, even from continent to continent, and have been assimilated to such an extent that rarely only there is any internal evidence that would indicate what is of native and what of foreign origin.

Although these incidents have a wide distribution, they have developed characteristic peculiarities in restricted parts of the territory in which they occur. I will illustrate this by means of some examples selected from among the folk-tales of the north Pacific coast of America.

An excellent illustration is presented by the North American tale of the Bungling Host. The fundamental idea of the story, the failure of the attempt to imitate magical methods of procuring food, is common to the whole North American Continent, apparently with the sole exception of California and of the Arctic coast. The incidents, however, show considerable variation. Confined to the north Pacific coast are the tricks of letting oil drip from the hands, of obtaining fishroe by striking the ankle, and of letting berries ripen by the song of a bird. The widely spread trick of cutting or digging meat out of the host's body is practically unknown on the north Pacific coast. The host's trick of killing his children, who revive, which forms part of the Bungling Host tale in the state of Washington and on the Plateaus, is well known on the north Pacific coast. However, it does not occur as part of this story. It is entirely confined to stories of visits to the countries of supernatural beings.

Similar observations may be made in regard to the prolific test theme. The dangerous entrance to the house of the supernatural beings is represented among the northern tribes of the north Pacific coast by the closing cave or by the closing horizon; among the tribes farther to the south, by a snapping door; on the western plateaus, by animals that watch the door of the house. Heat tests occur frequently, but in some regions the heat is applied by baking the youth in an

¹ Based on an investigation of the mythology of the Tsimshian, to be published in the Annual Report of the Bureau of American Ethnology.

oven or boiling him in a kettle; in others by sending him into an overheated sweat-lodge or placing him near a large fire. More important differences may be observed in the general setting of the test tales, which in some areas are tests of the son-in-law; in others, matches between the inhabitants of a village and their visitors.

Other examples of the local development of the plot of a story by the introduction of specific incidents occur, as in the north Pacific coast story of raven killing the deer, whom, according to the Alaskan tale, he strikes with a hammer, while in the more southern form he pushes him over a precipice. Similarly, in a story of a rejected lover who is made beautiful by a supernatural being the magic transformation is accomplished in the northern versions by bathing the youth in the bathtub of the supernatural being, while in the south he is given a new head.

In other cases the geographical differentiation of the tales is not quite so evident, because different types of stories overlap. This is the case in the widely spread story of the deserted child. Tales in which a youth gives offense by being lazy or by wasting food belong to Alaska. Another type, in which a girl is deserted because she has married a dog, belongs to British Columbia; but the two types overlap in distribution. This particular theme occurs in a much wider area on the American Continent, and other types may easily be recognized in the stories of the Plains Indians.

Tales of marriages with supernatural beings or animals are often found in the form of the abduction of a girl who has unwittingly offended an animal. This type seems to belong primarily to Alaska, while the theme of helpful animals that succor unfortunate and innocent sufferers is much more frequent among the tribes of British Columbia.

All these examples illustrate that there are a number of simple plots, which have a wide distribution, and which are elaborated by a number of incidents that must be interpreted as literary devices peculiar to each area. In all these cases the incidents obtain their peculiar significance by being worked into different plots.

On the other hand, we find also certain incidents that have a very wide distribution and occur in a variety of plots. Many examples of these are given in the annotations to all the more important recent collections of folk-tales. The local character of folk-tales is largely determined by typical associations between incidents and definite plots.

In most of the cases here discussed the plot has a general human character, so that the processes of invention and diffusion of plots must be looked at from a point of view entirely different from that to be applied in the study of invention and diffusion of incidents. The latter are, on the whole, fantastic modifications of every-day

experiences, and not likely to develop independently with a frequency sufficient to explain their numerous occurrences over a large area. On the other hand, the stories of a deserted child, of contests between two villages, of a rejected lover, and other similar ones, are so closely related to every-day experiences, and conform to them so strictly, that the conditions for the rise of such a framework of literary composition are readily given. Nevertheless the plots that are characteristic of various areas should be studied from the point of view of their literary characteristics and of their relation to the actual life of the people.

An attempt of this kind has been made by Dr. John R. Swanton,² who enumerates a number of formulas of tales of the north Pacific coast. In this area the following plots occur a number of times:

1. A woman marries an animal, is maltreated by it, and escapes.
2. A woman marries an animal, who pities and helps her; she returns with gifts.
3. Men or women marry animals and receive gifts; crest stories.
4. Men obtain crests through adventures in hunting or traveling.
5. Parents lose their children; a new child is born owing to the help of some supernatural being; adventures of this child.
6. A man maltreats his wife, who receives help from supernatural beings.
7. The adventures of hunters; they meet dangers, which the youngest or oldest one overcomes.
8. War between two tribes, due to the seduction of a woman and the murder of her lover.

All these stories show a unity of the underlying idea. They are built up on some simple event that is characteristic of the social life of the people and that stirs the emotion of the hearers. Some tales of this type are elaborated in great detail, and therefore conform to our own literary standards. To this class belongs, for instance, the tale of a deserted prince. It is told that a prince fed eagles instead of catching salmon. In winter when food was scarce he was deserted by his relatives, but was helped by the eagles, who gave him food. It is told in great detail how larger and larger animals were sent to him. When the prince had become rich he sent some food to the only person who had taken pity on him. By chance his good luck was discovered and he rescued the tribe that was starving and married the chief's daughter.

Another tale of this kind is "Growing-up-like-one-who-has-a-grand-mother." This is a tale of another poor boy who is helped by a supernatural being, overcomes all the young men of the village in various

² John R. Swanton, "Types of Haida and Tlingit Myths," *American Anthropologist*, N. S., Vol. VII., 1905, p. 94.

contests, and thus obtains the right to marry the chief's daughter. The chief feels humiliated, deserts him, and the youth kills a lake monster. When wearing its skin he is able to kill sea game, but finally is unable to take off the skin and must remain in the sea.

Besides these, there are a large number of complex tales of fixed form, which are put together very loosely. There is no unity of plot, but the story consists of the adventures of a single person. I do not refer here to the disconnected anecdotes that are told of some favorite hero, such as we find in the Raven legend or in the Transformer tales, but of adventures that form a fixed sequence and are always told as one story. Examples of this kind are quite numerous.

It is noticeable that only a few of the complex tales of the last-named type are known to several tribes. Although enough versions have been recorded to show that in each area the connection between the component parts of the story is firm, the whole complex does not migrate over any considerable distance. On the contrary, the parts of the tale have the tendency to appear in different connections. This point is illustrated, for instance, by the story of a man who is deserted on a sea-lion rock and is taken into the house of the wounded sea-lions whom he cures. This story appears in quite different connections in various regions. Other examples of similar kind are quite numerous.

The literary device that holds together each one of these tales consists in the use of the interest in the hero that has been created by the introductory story, and that makes the audience desirous of knowing about his further deeds and adventures. The greater the personal interest in the hero, the more marked is the desire to attach to his name some of the favorite exploits that form the subject of folk-tales. I presume this is the reason why in so many cases the introductory tales differ enormously, while the adventures and exploits themselves show a much greater degree of uniformity. This happens particularly in the case of tales of culture heroes. When a large number of the same exploits is thus ascribed to the heroes of different tribes, it seems to happen easily that the heroes are identified. Therefore I imagine that the steps in the development of a culture-hero myth may have been in many cases the following: An interesting story told of some personage; striking and important exploits ascribed to him; similar tales of these personages occurring among various tribes; identification of the heroes of different tribes. While I do not assume that this line of development has occurred every single time—and it seems to me rather plausible that in other cases the introductory story and the adventures may have come to be associated in other ways—it may be considered as proved that introduction and adventures do not belong together by origin, but are results of later association. The great diversity of associations of this type compels us to take this point of view.

On the whole, in many forms of primitive literature, the interest in the personality of the hero is a sufficient means of establishing and maintaining these connections. Nevertheless there are a few cases at least in which the adventures conform to a certain definite character of the hero. This is the case in northwestern America in the Raven, Mink, and Coyote tales, in which greed, amorous propensities, and vaingloriousness are the chief characteristics of the three heroes. In tales that have a more human background these tendencies are hardly ever developed.

The recorded material shows also that the imagination of primitive man revels in the development of certain definite themes, that are determined by the character of the hero, or that lend themselves in other ways to variation. Thus in Alaskan tales Raven's voraciousness, that induces him to cheat people and to steal their provisions, is an ever-recurring theme, the point of which is regularly the attempt to induce the people to run away and leave their property. Mink's amorousness has led to the development of a long series of tales referring to his marriages, all of which are of the same type. The strong influence of a pattern of thought on the imagination of the people is also illustrated by tales of marriages between animals and men or women and a few other types to which I referred before.

The artistic impulses of a people are not always satisfied with the loose connections of stories, brought about by the individuality of the hero, or strengthened by the selection of certain traits of his character illustrated by the component anecdotes. We find a number of cases in which a psychological connection of the elements of the complex story is sought. An example of this kind is found in the Raven legend of British Columbia, in which a number of unrelated incidents are welded into the form of an articulate whole. The adventures of the Steelhead Salmon, the Grizzly Bear, and Cormorant, are thus worked into a connected series. Raven kills Steelhead Salmon because he wants to use it to deceive Grizzly Bear. He holds part of the salmon in front of his body, so as to make the Bear believe that he has cut himself. Thus he induces the Bear to imitate him and to kill himself. Finally he tears out the tongue of Cormorant, who had witnessed the procedure, so that he may not tell. Another excellent case from the same region is the story of Raven's son and Thunderbird. Raven has seduced a girl, and their son is stolen by Thunderbird. In order to take revenge, he makes a whale of wood, then kills Pitch in order to calk the whale, and by its means drowns the Thunderbird. Among other tribes the same tale occurs in another connection. The animals have a game, and Thunderbird wins. The defeated guests are invited, and the host's wife produces berries by her song. Then the Thunderbird abducts her, and the revenge of the animals by means

of the whale follows. In the former group of tales the incident describing the death of Pitch is brought in, which ordinarily occurs as an independent story.

In these cases we find the same incidents in various connections, and this makes it clear that it would be quite arbitrary to assume that the incident developed as part of one story and was transferred to another one. We must infer that the elements were independent and have been combined in various ways. There certainly is nothing to prove that the connection in which an incident occurs in one story is older and nearer to the original form than one in which it occurs in another story.

The distribution of plots and incidents of North American folk-lore presents a strong contrast when compared to that found in Europe. European folk-tales, while differing in diction and local coloring, exhibit remarkable uniformity of contents. Incidents, plots, and arrangement are very much alike over a wide territory. The incidents of American lore are hardly less widely distributed; but the make-up of the stories exhibits much wider divergence, corresponding to the greater diversification of cultural types. It is evident that the integration of European cultural types has progressed much further during the last two or three thousand years than that of the American types. Cultural contrasts like those between the Northwest coast and the Plateaus, or between the Great Plains and the arid Southwest, are not easily found in Europe. Excepting a few of the most outlying regions, there is a great underlying uniformity in material culture, social organization, and beliefs, that permeates the whole European continent, and that is strongly expressed in the comparative uniformity of folk-tales.

For this reason European folk-lore creates the impression that the whole stories are units, that their cohesion is strong, and the whole complex very old. The analysis of American material, on the other hand, demonstrates that complex stories are new, that there is little cohesion between the component elements, and that the really old parts of tales are the incidents and a few simple plots.

Only a few stories form an exception to this rule—such as the Magic Flight or Obstacle myth—which are in themselves complex, the parts having no inner connection, and which have nevertheless a very wide distribution.

From a study of the distribution and composition of tales we must then infer that the imagination of the natives has played with a few plots, which were expanded by means of a number of motives that have a very wide distribution, and that there is comparatively little material that seems to belong to any one region exclusively, so that it might be considered as of autochthonous origin. The character of the folk-tales of each region lies rather in the selection of preponderant themes, in the style of plots, and in their literary development.

The supernatural element in tales shows a peculiar degree of variability. In a study of the varying details it appears a number of times that stories which in one region contain fantastic elements are given a much more matter-of-fact setting in others. I take my examples again from the north Pacific coast. In the tale of Raven's battle with South Wind we find in most cases an incident of an animal flying into the enemy's stomach, starting a fire, and thus compelling him to cough. In the Tsimshian version he simply starts a smudge in his house. In most tales of the liberation of the Sun the magical birth of Raven plays an important part, but among the Eskimo he invades the house by force or by ordinary fraud. In the Tsimshian tale of the origin of Raven a dead woman's child flies up to the sky, while the Tlingit tell the same tale without any supernatural element attached to it. Another case of this kind is presented by the wedge test as recorded among the Lower Thompson Indians. In most versions of this tale a boy who is sent into the open crack of a tree and whom his enemy tries to kill by knocking out the spreading-sticks, escapes miraculously when the tree closes. In the more rationalistic form of the tale he finds a hollow which he keeps open by means of supports given me. The available material gives me the impression that the loss of supernatural elements occurs, on the whole, near the border of the area in which the tales are known, so that it might be a concomitant of the fragmentary character of the tales. That loss of supernatural elements occurs under these conditions, appears clearly from the character of the Masset and Tlingit tales recorded by Swanton. In some of the Tlingit tales the supernatural elements are omitted, or weakened by saying that the person who had an incredible experience was out of his head. In the Masset series there are many cases in which the supernatural element is simply omitted. I am not prepared to say in how far this tendency may be due to conflicts between the tales and Christian teaching or in how far it may be due simply to the break with the past. The fact remains that the stories lost part of their supernatural character when they were told in a new environment.

I think it would be wrong to generalize and to assume that such loss of supernatural elements is throughout the fate of tales, for the distribution of explanatory tales shows very clearly that it is counter-balanced by another tendency of tales to take on new supernatural significance.

An additional word on the general theory of mythology. I presume I shall be accused of an entire lack of imagination and of failure to realize the poetic power of the primitive mind if I insist that the attempt to interpret mythology as a direct reflex of the contemplation of nature is not sustained by the facts.

Students of mythology have been accustomed to inquire into the

origin of myths without much regard to the modern history of myths. Still we have no reason to believe that the myth-forming processes of the last ten thousand years have differed materially from modern myth-making processes. The artifacts of man that date back to the end of the glacial period are so entirely of the same character as those left by the modern races, that I do not see any reason why we should suppose any change of mentality during this period. Neither is there any reason that would countenance the belief that during any part of this period intertribal contact has been materially different from what it is now. It seems reasonable to my mind, therefore, to base our opinions on the origin of mythology on a study of the growth of mythology as it occurs under our own eyes.

The facts that are brought out most clearly from a careful analysis of myths and folk-tales of an area like the northwest coast of America are that the contents of folk-tales and myths are largely the same, that the data show a continual flow of material from mythology to folk-tale and *vice versa*, and that neither group can claim priority. We furthermore observe that contents and form of mythology and folk-tales are determined by the conditions that determined early literary art.

The formulas of myths and folk-tales, if we disregard the particular incidents that form the substance with which the framework is filled in, are almost exclusively events that reflect the occurrences of human life, particularly those that stir the emotions of the people. If we once recognize that mythology has no claim to priority over novelistic folklore, then there is no reason why we should not be satisfied to explain the origin of these tales as due to the play of imagination with the events of human life.

It is somewhat different with the incidents of tales and myths, with the substance that gives to the tales and myths their highly imaginative character. It is true enough that these are not directly taken from every-day experience; that they are rather contradictory to it. Revival of the dead, disappearance of wounds, magical treasures, and plentiful food obtained without labor, are not every-day occurrences, but they are every-day wishes; and is it not one of the main characteristics of the imagination that it gives reality to wishes? Others are exaggerations of our experiences; as the power of speech given to animals, the enormous size of giants, or the diminutive stature of dwarfs. Or they are the materialization of the objects of fear; as the imaginative difficulties and dangers of war and the hunt, or the monsters besetting the steps of the unwary traveler. Still other elements of folk-lore represent ideas contrary to daily experiences; such as the numerous stories that deal with the absence of certain features of daily life, as fire, water, etc., or those in which birth or death are brought about by unusual means. Practically all

the supernatural occurrences of mythology may be interpreted by these exaggerations of imagination.

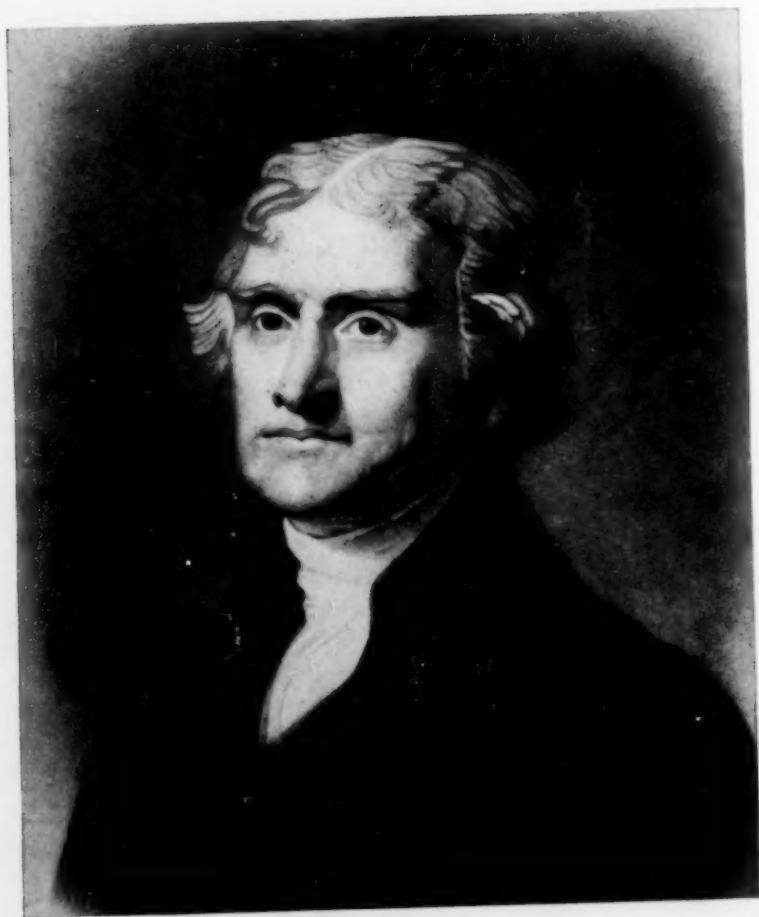
So far as our knowledge of mythology and folk-lore of modern people goes, we are justified in the opinion that the power of imagination of man is rather limited, that people much rather operate with the old stock of imaginative happenings than invent new ones.

There is only one point, and a fundamental one, that is not fully covered by the characteristic activity of imagination. It is the fact that everywhere tales attach themselves to phenomena of nature; that they become sometimes animal tales, sometimes tales dealing with the heavenly bodies. The distribution of these tales demonstrates clearly that the more thought is bestowed upon them by individuals deeply interested in these matters—by chiefs, priests, or poets—the more complex do they become, and the more definite are the local characteristics that they develop. The facts, however, do not show that the elements of which these tales are composed have any immediate connection with the phenomena of nature, for most of them retain the imaginative character just described.

The problem of mythology must therefore rather be looked for in the tendency of the mind to associate single tales with phenomena of nature and to give them an interpretative meaning. I do not doubt that when the anthropomorphization of sun and moon, of mountains and animals, had attracted stories of various kinds to them, then the moment set in when the observation of these bodies and of the animals still further stimulated the imagination and led to new forms of tales, that are the expressions of the contemplation of nature. I am, however, not prepared to admit that the present condition of myths indicates that these form any important part of primitive mythology.

That European myths happen to have developed in this direction—presumably by long-continued reinterpretation and systematization at the hands of poets and priests—does not prove that we must look for a poetic interpretation of nature as the primary background of all mythologies.

The mythological material collected in recent years, if examined in its relation to folk-tales and in its probable historical development, shows nothing that would necessitate the assumption that it originated from the contemplation of natural phenomena. It rather emphasizes the fact that its origin must be looked for in the imaginative tales dealing with the social life of the people.



THOMAS JEFFERSON.

THOMAS JEFFERSON IN RELATION TO BOTANY

BY RODNEY H. TRUE

WE are all familiar with Thomas Jefferson, the writer of the Declaration of Independence and the first great American radical leader, but we are less familiar with the fact that amid the political tempests which raged around him he never ceased to live the life of an ardent lover of the world of living things. In the volumes of his correspondence there appear not only letters dealing with the momentous questions of national life, neutrality, peace or war, slavery or no slavery, government by the people or only government for the people, but also many to men of science dealing with the various questions that agitated their world a hundred years ago. Systems of classification, identity of doubtful plants, problems of the cultivator in field and green-house, the introduction of new and useful kinds, and the best apportionment of time to be given to the several sciences found in the college curriculum are among the subjects of consideration both with American and with European correspondents. Jefferson was interested in all *useful* branches of science, and since his conception of utility was very broad, few lines of research that had developed in his day failed to receive some attention from this tireless man. The name of our great scientist-statesman, Benjamin Franklin, will occur to all minds in this connection. Undoubtedly Franklin's work on electricity was one of the greatest achievements yet credited to America. It is doubtful, however, whether he was in touch with so wide a range of scientific interests as was Jefferson.

Before we undertake a more detailed consideration of Jefferson's relations to botany, let us try to put him in his botanical setting by recalling some of the chief landmarks set up in that science during the years of his long life. Born in 1743, Jefferson as a four-year-old boy might have known Dillenius at the time of his death. He was six years old when Mark Catesby, the author of the famous "*History of Carolina, etc.*," passed away. He was two years old when Gronovius published Clayton's "*Flora of Virginia*." The chief botanical figures of the period covered by Jefferson's youth were Jussieu, the eldest; Philip Miller, of the "*Gardener's Dictionary*"; Peter Collinson, the witty English Quaker botanist and correspondent of Linnæus; John Bartram, of Philadelphia, likewise a Quaker; Dr. Alexander Garden, of Charleston, and the great Linnæus himself. That this youth knew nothing at this time of these men is most probable. Although destined in a few

short years to write the immortal Declaration, then revolutionary doctrine, that nations and peoples have a right to freedom of development, he was now oblivious of the fact that Linnæus was engrossing the attention of the world of science by inaugurating his peaceful revolution in classification and nomenclature. He was much more concerned with the smiles and frowns of Miss Sukey Potter and her friend, Miss Belinda Burwell. As he entered young manhood, among the prominent figures of earlier days now passing from the stage were some familiar to us: Cadwallader Colden, the botanizing governor of the New York colony died in the year of the Declaration of Independence, Bernard de Jussieu and John Bartram one year later, Linnæus two years later, and his pupil, the Swedish botanical explorer, Peter Kalm, three years later.

Among those who were boys with Jefferson were Humphrey Marshall, one of that famous group of Philadelphia Quaker naturalists who left his mark on American botany in his little book entitled "*Arbustum Americanum*"; Adam Kuhn, the first professor of botany in the College of Philadelphia, and perhaps in the whole country; André Michaux, the elder of that pair of French travelers and naturalists who added so largely to the botanical knowledge of America, and lastly, Laurent de Jussieu, through whose work chiefly the so-called Natural System of Classification found form and currency.

In Jefferson's first administration (1801-1805), Dr. Benjamin S. Barton, of Philadelphia, published his "*Elements of Botany*," the first great American botanical text-book, and Dr. David Hosack established near New York his Elgin botanical garden, later attached to Columbia College.

In the years immediately following Jefferson's retirement from the presidency appeared Barton's "*Flora Virginica*" (in part), F. A. Michaux's "*History of the Forest Trees of North America*," Pursh's "*Flora Americæ Septentrionalis*," and Mühlenberg's "*Catalogue*," which a few years later was brought on to the basis of the Natural System by the versatile diplomat, Abbé Corrêa, the Portuguese Minister to the United States. This same period witnessed the remarkable advance in chemistry marked by the discovery of oxygen by Priestly, from whom Jefferson received many letters. The work of Ingenhaus, of Vienna, and that of DeSaussure and of Senebier at Geneva developed the basal facts concerning the gaseous interchanges taking place in respiration and photosynthesis in plants. Thomas A. Knight, the pioneer in physiology and plant breeding, and Sir Humphry Davy, the great chemist and physicist, lived their most active days concurrently with Jefferson—also that "scourge of the human race," Napoleon. Jefferson's death took place in 1826, the year of the appearance of Darlington's "*Florula Cestrica*." It will bring Jefferson nearer to us to recall that in that year Asa Gray, whom the older of us here present this evening might

have known and studied with, was already a boy of sixteen, while his distinguished associate, Dr. John Torrey, was a young man of thirty years.

Having now established Jefferson's location in botanical chronology, let us turn to the man himself and, during the time remaining to us, examine his relations to our science and its progress during his time. It seems clear, from the evidence at hand, that, interested as he was in all lines of progress, Jefferson felt himself especially attracted to botany. Indeed, he may have come by such a leaning honestly enough through his mother, Jane Randolph. She was the daughter of Isham Randolph of Goochland county, Virginia, whose interest in plants was known in his lifetime beyond the bounds of the American colonies.

Peter Collinson, the English Quaker botanist, commemorated by Linnæus in the generic name, *Collinsonia*, wrote in February, 1739, to his friend, John Bartram, the Quaker botanist of Philadelphia, who was about to undertake a tour of scientific investigation into Virginia:

Then when thee proceeds home, I know no person who will make thee more welcome than Isham Randolph. He lives thirty or forty miles above the falls of the James River, in Goochland—above the other settlements. Now I take his house to be a very suitable place to make a settlement at—for to take several days' excursions all around, and to return to his house at night.

His further advice to Friend Bartram is hardly botanical in its subject matter, but since it sheds light on Jefferson's grandfather and on his way of living in that remote frontier settlement, I may perhaps be permitted to quote a few lines further.

One thing I must desire of thee, and do insist that thee oblige me therein; that thou make up that drugged clothes, to go to Virginia in, and not appear to disgrace thyself or me; for though I should not esteem thee the less, to come to me in what dress thou wilt,—yet these Virginians are a very gentle, well-dressed people—and look, perhaps, more at a man's outside than his inside. For these and other reasons, pray go very clean, neat, and handsomely dressed to Virginia. Never mind thy clothes, I will send more another year."

He met Isham and found him all that Collinson had promised. Moreover, Bartram found Isham able to guide him to an interesting conifer which Bartram later pronounced "much the finest *Arborvitæ*, surpassing one he had obtained from Cadwallader Colden from Hudson's River."

However it came about, by inheritance or otherwise, we may be assured that Jefferson's interest in botany was unusually keen. Writing in November, 1808, to his son-in-law, Colonel Thomas Mann Randolph, concerning the education of his grandson, Thomas Jefferson, then President at Washington, says:

For a scientific man in town nothing can furnish so convenient an amusement as chemistry, because it can be pursued in his cabinet; but for a country gentleman, I know no source of amusement and health equal to botany and

natural history; and I should think it unfortunate for such an one to attach himself to chemistry, altho' the general principles of the science it is certainly well to understand.

In a letter written October 7, 1814, to Dr. Thomas Cooper of Columbia, S. C., in which university courses are the subject of discussion, Jefferson claims for botany a high rank among the practical sciences, since it deals with the sources of food, fibers and other important products, among which he mentions ornamentals. Botany as a humanizing influence again finds its office recognized.

No country gentleman should be without what amuses every step he takes into his fields.

The interest taken by Jefferson in the study of plants seems to have been shared by several of his plantation-owning neighbors. Indeed, the circumstances surrounding the Virginia planter before the coming to life of the slavery issue were probably as favorable to the development of the accomplishments and graces as have ever existed. Large interests close at hand, supervised by his own eye, an abundant living and few distractions beyond those incident to the hospitalities of the times gave the possessor the leisure needed for the cultivation of such interests as might commend themselves to him. It is then hardly surprising that in a region shown by Bartram and others to be so rich in new and interesting plants there should be a marked activity in the study of botany among the men of leisure living there.

It is probable that Jefferson's early interest in the subject may have been such an amateur interest intensified by his inheritance of some of the tendencies seen in Isham Randolph. It seems to have been characteristic of Jefferson that when his interest in a subject was really aroused he went into the matter as far as circumstances would permit. In his desire to have the necessary resources at hand, the available book markets were ransacked. Like the true collector, he was not satisfied to borrow a book, he must needs own it, then lend it generously to others and perhaps lose it. A single letter may suffice to illustrate one of these characteristics. It was written in January, 1783, at Philadelphia, where Jefferson was Washington's Secretary of State, to Mr. Francis Eppes, a neighboring planter and father of his future son-in-law. Mr. Eppes, acting as Jefferson's emissary, was trying to get a much-desired book from his neighbor, Mr. Bolling. After writing about Gibraltar and affairs at the British court Jefferson says:

Since I came here there has been sold the Westover copy of Catesby's History of Carolina. It was held near a twelve month at twelve guineas, and at last sold for ten. This seems to fix what should be given for Mr. Bolling's copy, if you can induce him to let you have it, which I am anxious for.

It is not known what success Mr. Eppes had with Mr. Bolling, but among the remarkable collection of books which Jefferson made and which in 1815 became the nucleus of the present Library of Congress,

there was a copy of Catesby. His botanical library became in time one of the best in America, a fact attested by the frequent loan of rare volumes to students of plants not so fortunate as to own copies themselves.

Remarkable as was the breadth and intensity of Jefferson's interests in affairs, he was not the author of many books. The service demanded of him by state and country with little intermission from his election to the House of Burgesses of the Colony of Virginia in 1769 to his retirement from the Presidency forty years later, gave him at no time the continuous leisure required for doing any large body of original investigation. We find, therefore, outside of the myriad references more or less extended to matters of science (and botany in particular) preserved in his very voluminous correspondence, but one extended work, a book appearing first under date of 1782, entitled "Notes on Virginia." And that book became one through no deliberate intention on the part of Jefferson to be an author on this subject. His friend, the French representative to America, M. de Marbois, wishing information for friends in Europe, begged Jefferson to set down answers to a series of questions dealing with the main points of interest and importance concerning his native state. In response to this request, Jefferson wrote down rapidly and without great research the series of chapters which eventually became the book mentioned. These chapters dealt more completely and scientifically with Virginia than any previous work had done with any of the sister states and has been referred to by General Greely as the first great American contribution to scientific geography. The book ran through many editions in English, and through several in a very inaccurate French version published without Jefferson's knowledge or consent. A German edition also appeared.

Probably this book represents the first important contribution made by Jefferson to biological science and serves as a landmark in his career. The chapter dealing with the flora of the state gives lists of medicinal, esculent, ornamental and otherwise useful native plants. The common names as well as the Linnæan names were used. Not finding the pecan described in Miller, Linnæus or Clayton, he says, "Were I to venture to describe this, speaking of the fruit from memory, and of the leaf from plants of two years' growth, I should specify *Juglans alba, foliolis lanceolatis, acuminatis, serratis, tomentosis, fructa minore, ovato, compresso, vix insculpto, dulci, putamine tenerrime*," (which translated says this: *Juglans alba*, with leaflets lanceolate, acuminate, serrate, tomentose, fruit small, ovate, compressed, little sculptured, sweet, shell thin.) "It grows on the Illinois, Wabash, Ohio and Mississippi." This description was written in 1781 or early in 1782 and appeared in print in Paris in 1784, one year before Humphrey Marshall described the pecan in his "*Arbustum Americanum*," the work in which the

nomenclatorial history of this tree is considered by some to have had its beginning.

In order to contrast the botanical workmanship of Jefferson with that of Marshall, I will read the description in the "*Arbustum Americanum*" p. 69, on which Marshall has received credit for first introducing the pecan to science:

S. Juglans pecan. The Pecan or Illinois Hickory.

This tree is said to grow plenty in the neighborhood of the Illinois River, and other parts to the Westward. The young trees raised from these nuts, much resemble our young Pig-nut Hickeries. The nuts are small and thin shelled.

To my mind Marshall's description fails to distinguish the pecan plant from the pig-nut hickory he mentions, while the name proposed by him is left so nearly nude that its title to priority is doubtful. The earlier, clean-cut, adequate diagnosis by Jefferson, can only on bibliographic technicality fail to secure for him the credit of being the first scientific sponsor for the pecan.

As a matter of fact, the pecan had been known to several American botanists almost twenty-five years before either of these books appeared. Colonel Bouquet obtained them at Pittsburgh and gave them to John Bartram, who seems to have sent them to several of his correspondents. Peter Collinson and John St. Clair almost certainly received some in 1760 or 1761. Since at that time Jefferson was still at the Belinda Burwell-Sukey Potter stage, he could hardly have been interested in the interchange of letters between John Bartram and Peter Collinson produced by Colonel Bouquet's "seven hard, stony seeds shaped something like an acorn." It seems probable that Collinson showed these puzzling nuts to his friend, James Gordon, a prominent nurseryman living near London, whom the generic name of the Loblolly bay, *Gordonia*, commemorates. The result amuses Peter, who writes to his friend John:

I do laugh at Gordon, for he guesses them to be a species of Hickory.

Then he continues, this time in the vein of true prophesy.

Perhaps I may be laughed at in turn, for I think they may be what I wish, seeds of the Bonduc tree, (Kentucky coffee tree), which thou picked up in thy rambles on the Ohio.

Characteristically enough, Jefferson throughout his correspondence which turned not rarely on this nut, consistently refers to it as the paccan or Illinois nut. In France where he represented the United States in a diplomatic capacity, we find him enthusiastically introducing it to the Frenchmen. Writing from Paris on January 3, 1786, to his Philadelphia friend, Francis Hopkinson, the early American song writer and signer of the Declaration of Independence, after indicating a number of errands to be done for him, Jefferson says,

The third commission is more distant. It is to procure me two or three hundred paccan-nuts from the Western country. I expect they can always be

got at Pittsburg, and am in hopes, that by yourself or your friends, some attentive person there may be engaged to send them to you.

He continues with characteristic explicitness:

They should come as fresh as possible, and come best, I believe, in a box of sand.

Nearly a year elapses before he hears from Hopkinson who evidently is not clear that he has obtained the right thing and Jefferson replies to him from Paris, December 23, 1786. "The paccan nut is, as you conjecture, the Illinois nut. The former is the vulgar name south of the Potomac, as also with the Indians and Spaniards, and enters also into the botanical name, which is *Juglans paccan*." Here it will be noted he adopts Marshall's proposed name.

During the years spent in Paris, Jefferson was at the very heart of European activity and in the lack of newspapers he served as a reporter on the progress of science for some of his American friends as well as for Harvard, Yale, and perhaps other institutions. Among those to whom he frequently wrote on subjects of this nature was his good friend Bishop James Madison, the President of William and Mary College, at Williamsburg, Va. A letter written by him on July 19, 1788, at Paris will show how well Jefferson played the part of scientific scout for America.

You know also that Dr. Ingenhauss had discovered, as he supposed, from experiment, that vegetation might be promoted by occasioning streams of the electrical fluid to pass through a plant, and that other physicians had received and confirmed this theory. He now, however, retracts it, and finds by more decisive experiments, that the electrical fluid can neither retard nor forward vegetation. Uncorrected still of the rage of drawing general conclusions from partial and equivocal observations, he hazards the opinion that *light* promotes vegetation. I have heretofore supposed from observation, that light affects the color of living bodies, whether vegetable or animal; but that either the one or the other receives nutriment from that fluid must be permitted to be doubted of, till better confirmed by observation.

The state of physics at that time is keenly illuminated by his remarks on light as a fluid like electricity. How inadequate the view before the conceptions of energetics entered is shown by the remark concerning the non-nutritiousness of the light fluid.

Jefferson closes this letter with a little rather debatable philosophy growing out of this ill fortune of the efforts of Ingenhauss.

It is always better to have no ideas than false ones; to believe nothing, than to believe what is wrong. In my mind, theories are more easily demolished than rebuilt.

Fortunately for Thomas Jefferson and for us, he was never able to rigidly follow this creed of skepticism. Of the truth of his observation on the perishability of theories we can all bear him witness.

It may be of interest to note in passing that last year I found among the remains of Jefferson's library now in the Library of Congress a copy of Ingenhauss's book entitled "Experiments on Vegetables."

In 1791 in company with his plant-loving friend Madison, Jefferson

had occasion to take an extended turn through the Northern States. This opened to their eyes a new flora as seen in the first week of June. Jefferson writes enthusiastically to his son-in-law, and fellow lover of plants, Thomas Mann Randolph:

BENNINGTON IN VERMONT, June 5, 1791.

Dear Sir: Mr. Madison and myself are so far on the tour we had projected.

After describing the battlefield of Saratoga he continues:

We have also visited Forts William, Henry and George, Ticonderoga, Crown Point, etc., which have been scenes of blood from a very early part of history—We were more pleased, however, with the botanical objects which continually presented themselves. Those either unknown or rare in Virginia, were the sugar maple in vast abundance, the silver fir, white pine, pitch pine, spruce pine, a shrub with decumbent stems, which they call juniper, an azalea very different from the nudiflora, with very large clusters of flowers, more thickly set on the branches, of a deeper red and high pink-fragrance. It is the richest shrub I have seen. The honeysuckle of the gardens growing wild on the banks of Lake George, the paper birch, an aspen with a velvet leaf, a shrub-willow with downy catkins, a wild gooseberry, a wild cherry with single fruit (not the bunch cherry), strawberries in abundance.

The azalea here referred to with such enthusiasm, was in the opinion of Mr. W. W. Eggleston, probably *A. canadensis*, first normally described twelve years later in 1803 by Michaux the elder. Had Jefferson taken the trouble to give his observations the form of conventional descriptions, it is quite likely that his discoveries would have added several plants then new to science.

During the next decade, that preceding his first presidency, Jefferson found his time very largely occupied with the duties involved in the positions of Secretary of State, under Washington, and Vice-president with John Adams, but incidentally he serves as President of the American Philosophical Society, he writes an essay on the study of Anglo-Saxon, he drafts the famous Kentucky resolutions, makes preliminary plans for an educational institution which in the later years of his life became the University of Virginia, and prepares a parliamentary manual, still in very general use in legislative assemblies. During this period he was the recognized leader of the newly formed Republican party and as such was involved in what was perhaps the most bitter partisan contest ever waged in our political history.

During this period there are many incidental proofs of his continued pleasure in botany as when on April 1, 1892, at Mrs. Trist's desire he sends to Benjamin Hawkins

about a dozen beans of three different kinds, having first taken toll of them as she has done before. They are of the scarlet flowering kind. This is all I know of them. The most beautiful bean in the world is the Caracalla bean, which though in England a greenhouse plant, will grow in the open air in Virginia and Carolina. I could never get one of these in my life. They are worthy your enquiry.

On June 2, 1793, writing from Philadelphia, he does a good turn for his friend John by writing to James Madison:

Bartram is exceedingly anxious to get a large supply of seeds of the Kentucky coffee tree. I told him I would use all my interest with you to obtain it, as I think I heard you say some neighbors of yours had a large number of trees. Be so good as to take measures for bringing a good quantity, if possible, to Bartram when you come to Congress.

During his stay in Paris from 1784 to 1789, Jefferson had made the acquaintance of many men of science, and his reputation brought him many correspondence-acquaintances. When, therefore, the French Revolution, later became European chaos through the deeds of Napoleon, many men of science found little opportunity to pursue their studies. Jefferson received letters from several of these friends who desired a quiet haven in America. The University of Geneva, with Edinburgh, declared by Jefferson to be the "eyes of Europe" was involved in the general disaster. Washington, having received a present from Virginia in the shape of some shares in the Potomac and James River Companies, desired to place them where in some far-reaching way they might work for the public good, and before bestowing them sought Jefferson's advice. With a boldness which was characteristic of him when great opportunities were in sight, Jefferson proposed to Washington the transfer bodily of the University of Geneva to some place near the Federal city (Washington) where it should become the beginning of the National University of America. He proposed the organization of a professorship in agriculture which should present this branch in a series of lectures. The University was not transferred and Jefferson's glorious dream faded. One can not but ponder what such a transfer would have meant to America. The germ of the most important work in plant physiology lay in two members of that faculty. Through the epoch-making work of Theodor de Saussure and of Jean Senebier, aided by their above condemned Austrian colleague Ingenhauß, the foundations for the understanding of the processes of photosynthesis and respiration were laid. At the time this bold conception captured Jefferson these men were approaching their prime, only a few years later to dazzle the world of science with their brilliant achievements. Had that work been performed at the new National University of America situated near the Federal city one of the great ideals of Jefferson's life would have been realized.

The relation of Jefferson to science and botany in particular up to the time of his first presidency had been essentially that of a keenly interested and very intelligent amateur. He had been an intermediary between scientists, had on several occasions expressed his own views on current scientific problems and in some cases had anticipated the specialists themselves.

In 1802, however, the greatest scientific opportunity of his life came to Jefferson with the purchase of Louisiana. At this time there came under the flag of the United States a vast unknown area for exploration and settlement. The Missouri River with St. Louis as a starting point had for years been a highway into that country swarming with

herds of bison and antelope and peopled with war-like but interesting Indian tribes. Fur traders and their like had brought back such information as was to be had about the country. The fascination of this great unknown wilderness had long before taken possession of Jefferson. While a resident in Paris he had become acquainted with John Ledyard, one of those nomads who roamed the world in search of adventure. Ledyard had been with Captain Cook in his famous voyage through Behring Straits and was with him on his last fateful visit to the Sandwich Islands. He came to Paris in 1786 ready for a new quest and was urged by Jefferson to traverse Europe and Siberia to Kamtschatka, to cross in Russian vessels to Alaska, then a Russian possession, to go southward to the latitude of the Missouri River, from which point he was to travel eastward to the headwaters of that river and along its course through Louisiana to the United States. Ledyard attempted to carry out this program, but through interference from the Russian government his plans were thwarted.

Nothing daunted by the unhappy outcome of this attempt, Jefferson proposed to the American Philosophical Society that a subscription be made up from private sources to finance an expedition up the Missouri River from St. Louis to cross what Jefferson called the "stony mountains"¹ to some corresponding stream on their farther slope, the course of which was to be traced westward to the ocean. Caspar Wistar, getting wind of these plans, in June, 1792, tried to get his Philadelphia friend Dr. Moses Marshall to confer with Jefferson with the purpose in view of undertaking the task.² But Dr. Marshall having been appointed justice of the peace, was diverted permanently from botany (Harshberger). The leadership was proposed to André Michaux, who accepted the rather rigorous terms of the promoters of the enterprise. Jefferson, speaking for the Philosophical Society, gave Michaux his instructions which, did time permit, would make very interesting reading. Michaux reached Kentucky only to be recalled by the French government to carry out a program of exploration for which he had been previously employed by it.

A third attempt was soon planned, this time with government aid. In January, 1803, acting on a confidential message from Jefferson, Congress approved his recommendation that a sum deemed sufficient to carry out the project be appropriated, and Jefferson lost no time in appointing his old neighbor and private secretary, Captain Meriwether Lewis, to take charge of the expedition. After associating with himself William Clark of Kentucky, Lewis, in April, 1803, received the necessary credentials and instructions from President Jefferson covering all points of policy likely to arise. To prepare himself the better for his work Lewis spent some months in Philadelphia receiving instruction

¹ Mem. Ed., XVIII, 144.

² Darlington, "Memorials of John Bartram and Humphrey Marshall," p. 570.

in science from the eminent men residing there. Dr. Benjamin S. Barton chiefly took his tuition in botany in hand and consulted freely on those phases of the plan dealing with zoology and anthropology as well. The expedition, despite much fatigue and suffering, was carried out successfully and after about two years' absence returned with much material of great value to natural history. In accordance with the terms of the agreement with the government, Captain Lewis was to have charge of the working up of the material and was to retain the right to first publish the results. The collections seem to have been placed by Lewis in the hands of qualified investigators before he assumed the post as governor of the new Louisiana territory to which he was soon appointed. Not long after, while suffering from a mental illness, he is said to have committed suicide. The decease soon after of Dr. Benjamin S. Barton, who was in charge of much of the material, and the bankruptcy of the bookmaker who was to have published the results threatened even at this late date to frustrate the object of the entire undertaking. The story of the adventures of the herbarium material makes a tale to stir botanists. We shall get a part of it from letters quoted below.

The seeds collected by the expedition seem in a measure to have been taken in charge by Jefferson, who divided the major part of them into two portions, which were given to Bernard McMahon, a botanist and nurseryman living in Philadelphia and to William Hamilton of the same place, the wealthy owner of the famous gardens known as "The Woodlands," by whom they were successfully grown.

The history of a number of the plants grown from these seed is traced in the correspondence between Jefferson and McMahon. These letters show, moreover, that Jefferson was the one stable element in the chaotic situation that had come to pass, and in the end he more than any other one man was able to save and bring within reach of the public the results of this expedition. McMahon writes from

PHILADELPHIA, June 28, 1808.

Dear Sir: I am happy to inform you that I have fine plants of all the varieties of currants (7) and gooseberries (2) brought by Govr. Lewis, and of about 20 other new species of plants, as well as five or six new genera; This will add to natural history and the plants are forthcoming.

To this Jefferson replies (in part), from

WASHINGTON, July 6, 08.

... I received only a few of Govr. Lewis's articles and have here growing only his salsafia, mandane corn and a pea remarkable for its beautiful blossom and leaf, his forward bean is growing in my neighborhood.

On December 24, 1809, not long after the tragic death of Governor Lewis became known, McMahon writes from Philadelphia:

I am extremely sorry for the death of that worthy and valuable man, Govr. Lewis, and the more so, for the manner of it. I have, I believe, all his collection of dried specimens of plants, procured during his journey to the

Pacific Ocean, and several kinds of new living plants, which I raised from the seed of his collecting which you and himself were pleased to give me. In consequence of a hint to that effect, given me by Govr. Lewis on his leaving this City, I never yet parted with one of the plants raised from his seeds, nor with a single seed the produce of either of them, for fear they would make their way into the hands of any botanist, either in America or Europe who might rob Mr. Lewis of the right he had to first describe and name his discoveries, in his intended publication; and indeed, I had strong reasons to believe this opportunity was coveted by ——— which made me still more careful of the plants.

On Governor Lewis's departure from here, for the seat of his government, he requested me to employ Mr. Frederick Pursh, on his return from a collecting excursion he was then about to undertake for Dr. Barton, to describe and make drawings of such of his collection as would appear to be new plants and that himself would return to Philadelphia in the month of May following. About the first of the ensuing November, Mr. Pursh returned, took up his abode with me, began the work, progressed as far as he could without further explanation in some cases, from Mr. Lewis, and was detained by me, on expectation of Mr. Lewis's arrival at my expense, without the least expectation of any future remuneration, from that time till April last; when not having received any reply to several letters I had written from time to time, to Govr. Lewis on the subject, not being able to obtain any information when he might be expected here, I thought it a folly to keep Pursh longer idle, and recommended him as gardener to Dr. Hosack of New York, with whom he has since lived. The original specimens are all in my hands, but Mr. Pursh had taken his drawings and descriptions with him, and will, no doubt, on the delivery of them expect a reasonable compensation for his trouble. As it appears to me probable that you will interest yourself in having the discoveries of Mr. Lewis published, I think it a duty incumbent on me to give you (*the Ms. is here torn*) preceding information, and to ask your advice as to the propriety of still keeping the living plants I have from getting into other hands who would gladly describe and publish them without doing due honor to the memory and merit of the worthy discoverer. I am, sir, with the most sincere esteem, your well wisher, etc.

BERND. McMAHON

It is not necessary to philosophize on the sad state of those times when botanists were jealous of each other's new species. The part played by McMahon, the gardener, seedsman and botanist, as a sort of central, connecting Lewis, the collector, Pursh, the botanist, and Jefferson, the prime mover in the whole enterprise is clearly indicated.

Not to tarry longer, it may be said that from the seeds placed with McMahon and Hamilton for propagation at the hands of expert gardeners came several plants well known to us all. The osage orange, or bois d'arc (*Maclura pomifera* Schneider) in time came into very general use in the central and southern parts of the country as a hedge plant. Others are mentioned in subsequent letters.

On February 18, 1812, McMahon sent to Jefferson among other of Lewis's plants, (1) "*Ribes odoratissimum* (Mihi), an important shrub, the fruit very large, of a dark purple colour, the flowers yellow, showy and *extremely fragrant*"; (2) *Symphoricarpos leucocarpa* (Mihi), which he described and to which he gives the English name of Snow-berry bush, which it still retains; (3) "The yellow currant of the

River Jefferson, that is specifically different from the other, but I have not given it a specific botanical name." He closes his letter by referring to another subject which is quoted as showing his attitude toward Jefferson in a botanical matter.

I would thank you to inform me whether you take the Gloucester nut to be a distinct species as announced by Michaux f. (*Juglans laciniosa*) or whether if only a variety it is nearer allied to the *Juglans tomentosa* Mich. or to the *J. squamosa* Mich. f., the *J. alba* of his father.

But I must not quote more of this interesting correspondence.

In time, through the help of Abbé Corrêa de Serra and others, Jefferson was able to rescue a considerable part of the notes of the Lewis and Clark expedition from their various hiding places and to get them into the hands of a publisher, Paul Allen, for whom he wrote a brief biographical sketch of Meriwether Lewis.

Speaking summarily of Jefferson's relation to the Lewis and Clark expedition, it is clear that Jefferson inspired and sustained this famous enterprise, determined its course and in the end, outliving all others who had had a scientific interest in the enterprise, secured the benefits of its results to the country. Viewed broadly, this expedition was perhaps Jefferson's greatest contribution to science in general and to botany in particular.

During the years of retirement at Monticello, he took an interest in whatever was happening in the world of ideas. His correspondence with botanists at that period touches on all phases of the science then developing. The old artificial system of classification proposed by Linnæus had proved a great blessing when it was formulated, but as the study of life became more thorough and comprehensive, it is not surprising that new standpoints should have developed and that some system of arrangement should have been sought that in a certain ideal way would express more fully the truths of affinity and relationship than did the Linnæan system. Hence, it came about that the so-called "Natural System" associated with the name of Laurent de Jussieu formulated in his "Genera Plantarum" attracted much attention in the scientific world in 1789. In those days ideas were propagated rather slowly from their point of origin and it was not till nearly twenty-five years later that the reign of the Linnæan system was challenged in America. In 1815, the Abbé Corrêa de Serra, then lecturing on botany in the College of Philadelphia in succession to Benj. S. Barton, reduced Mühlenberg's "Catalogue" to the Natural System for the use of his hearers. Jefferson, in his retirement, was not entirely outside of the reach of ensuing botanical controversy. Since his opinion seems to have been solicited by numerous correspondents on many subjects of disagreement, we are not surprised to find Dr. John Mannes subjecting the aged ex-president to a catechetical examination on the articles of his taxonomic faith. On January 24, 1814, Dr. Mannes desires to know the comparative merits of the different methods of classifica-

tion adopted by different writers on Natural History. In his rather complete reply to the doctor written from Monticello, February 22, 1814, Jefferson approaches the problem in its broadest possible aspect. I quote here only in part.

. . . The text of this answer will be found in an observation in your letter, when, speaking of the nosological systems, you say that disease has been found to be an unit. Nature, has, in truth, produced units only through all her works. Classes, orders, genera, species are not of her work. Her creation is of individuals. No two animals are exactly alike; no two plants, nor even two leaves or blades of grass; no two crystallizations. . . . This infinitude of units or individuals are far beyond the capacity of our memory. We are obliged, in aid of that, to distribute them into masses, throwing into each of these all individuals which have a certain degree of resemblance; to subdivide these again into smaller groups, according to certain points of dissimilitude observable in them, and so on until we have formed what we call a series of classes, orders, genera and species. In doing this we arbitrarily fix on such characteristic resemblances and differences as seem to us most prominent and invariable in the several subjects, and most likely to take a strong hold in our memories. Thus Ray formed one classification on such lines of division as struck him most favorable; Klein adopted another; Brisson a third, and other naturalists other designations, till Linnæus appeared. Fortunately for science, he conceived in the three kingdoms of nature, modes of classification which obtained the approbation of the learned of all nations. His system was accordingly adopted by all, and united all in a general language. . . . This classification was indeed liable to the imperfection of bringing into the same group individuals which, though resembling in the characteristics adopted by the author for his classification, yet have strong marks of dissimilitude in other respects. But to this objection every mode of classification must be liable. . . . Nature has not arranged her productions on a single and direct line. They branch at every step, and in every direction, and he who attempts to reduce them into departments, is left to do it by the lines of his own fancy. . . . But neither is this so important a consideration as that of uniting all nations under one language in Natural History. . . . Linnæus' method was received, understood and conventionally settled among the learned, and was even getting into common use. To disturb it then was unfortunate. The new system attempted in botany by Jussieu . . . is subject to the same regret. . . . I adhere to the Linnæan (system) because it is sufficient as a ground-work, admits of supplementary insertions as new productions are discovered, and mainly because it has got into so general use that it will not be easy to displace it, and still less to find another which shall have the same singular fortune of obtaining the general consent. . . . I am not myself apt to be alarmed at innovations recommended by reason. That dread belongs to those whose interests or prejudices shrink from the advance of truth and science. My reluctance is to give up an universal language of which we are in possession, without an insurance of general consent to receive another.

There would seem to be little encouragement here for a bibliographic botanist with his new combinations and resurrected ghost species; and as little for the man who regards a proposed new species as a piece of property belonging to him by moral right. The greatest service to the greatest number was the test to which Jefferson brought all things.

We must now pass to the consideration of another phase of Jefferson's influence on botany, that exerted in the academic sphere. And

we are not surprised to learn that largely as a result of Jefferson's initiative, the State of Virginia in 1818 appropriated the sum of \$15,000 to be devoted to the building, equipment and manning of a State University. Likewise, largely through the influence of Jefferson, it came eventually to be located at Charlottesville. In spite of his many years, Jefferson was chosen head of the institution. In calling him to be rector of the university, the authorities could have hardly known how well they had chosen. Jefferson, already beyond his three score and ten, now turned architect and planned and caused to be built those structures which have made the University of Virginia one of the famous shrines of the building art in America. Then came the filling of eight professorships, chiefly by men from abroad. That of Natural History was filled on March 4, 1825, by the appointment of Dr. John Patten Emmett of New York, who was called to occupy, not a chair, but as somebody else has said, "a bench," for he gave instruction in chemistry, botany, zoology, mineralogy, and geology. Being himself a chemist one is not surprised to find him in the following year pleading with the rector for a laboratory room for his chemistry work. It seems likely that he found it hard to get time for the botany since Jefferson seems to have been compelled to write him a letter asking him to plan on getting his botany courses into operation.

This letter shows the same energy, foresight, and sense for the practicable that put through the exploration of Louisiana. It is full of the enthusiasm for botany that he looked for in his young professor, but what is more to our present purpose, it gives a clear idea of what was taught under the name of botany in those days, and what equipment was regarded as necessary. On April 27, 1826, he wrote to Dr. Emmett as follows:

Dear Sir: It is time to think of the introduction of the School of Botany into our Institution. Not that I suppose the lectures can be begun in the present year, but that we may this year make the preparations necessary for commencing them the next, for that branch, I presume, can be taught advantageously only during the short season while Nature is in general bloom, say, only during a certain portion of the months of April and May, when suspending the other branches of your department, that of Botany may claim your exclusive attention. Of this, however, you are to be the judge, as well as of what I may now propose on the subject of preparation.

He then refers to suggestions made at his request by the late Abbé Corrêa regarding the most advisable way of utilizing a plot of 6 acres of ground available for a botanic garden. The lower flatter stretches were best used for the garden of plants, the terraced hill slopes for the arboretum. Owing to lack of funds a greenhouse was not to be considered. This area was to be enclosed and a gardener of sufficient skill was to be engaged. He then continues:

Make out a list of the plants thought necessary and sufficient for botanical purposes, and of the trees we propose to introduce and take measures in time for procuring them. As to the seeds of plants, much may be obtained from the gardeners of our own country. I have, moreover, a special resource. For

three and twenty years of the past twenty-five, my good friend Thouin, Superintendent of the Garden of Plants at Paris, has regularly sent me a box of seeds, of such exotics as to us, as would suit our climate, and containing nothing indigenous to our country. These I regularly sent to the public and private gardens of the other states, having as yet no employment for them here. But during the last two years this envoi has been intermitted, I know not why. I will immediately write and request a recommencement of that kind office, on the ground that we can now employ them ourselves. They can be here in the early spring. The trees I should propose would be exotics of distinguished usefulness, and accommodated to our climate. Such as the Larch, Cedar of Libanus, cork-oak, the Marronnier (Spanish Chestnut), Mahogany, the catachu or Indian rubber tree of Napul (30°), Teak tree or Indian oak of Burman (23°) the various woods of Brazil, etc. The seed of the Larch can be obtained from a tree at Monticello, cones of the cedar of Libanus are in most of our seedshops, or may be had fresh from the trees in English gardens. The Marronnier and cork-oak, I can obtain from France. There is a Marronnier at Mount Vernon, but it is a seedling, and not therefore select. The others may be got through the means of our Ministers and Consuls in the countries where they grow, or from the seed shops of England where they may very possibly be found.

He closes his letter with a characteristic clause, "but let us at once enter on the operations."

On May 2, about eight weeks before his death, he being then 83 years old, Jefferson explains in a long letter to Professor Emmett, who finds his time overloaded, how he can reduce his difficulties by careful planning.

Suppose then you give 12 doz. lectures a year: say 2 doz. to botany and zoology, 2 doz. to mineralogy and geology, and 2 doz. to chemistry, or I should think that mineralogy, geology and chemistry might be advantageously blended in the same course, then your year would be formed into two grand divisions, 1/3 to botany and zoology and 2/3 to chemistry and its associates, mineralogy and geology. You will say that 2/3 of a year, or any better estimated partition of it, can give but an inadequate knowledge of the whole science of chemistry, but consider that we do not expect our schools to turn out their alumni already enthroned on the pinnacles of their respective sciences, but only so far advanced in each as to be able to pursue them by themselves and to become Newtons and Leplaces by energies and perseverences to be continued through life.

In his day Jefferson was the recipient of many distinguished honors conferred by societies and universities in America and Europe. Well did DeKay, the naturalist, refer to him in his late years as "the Great Patriarch of American Natural History." His own estimate of his life's work is reflected in the epitaph beneath which he desired to rest:

Here was buried Thomas Jefferson author of the Declaration of Independence, of the statute of Virginia for religious freedom and father of the University of Virginia.

For the use of the portrait of Jefferson which illustrates this paper the writer is indebted to Mrs. Edwin Kirk, of Washington, D. C., a descendant of Jefferson. The engraving was made from an oil painting by Gilbert Stuart and is traditionally regarded by members of this branch of the family as one of the best portraits of their great ancestor.

OUR NATIONAL PROSPERITY
DISTRIBUTION OF PROPERTY AND INCOME

By CHAS. A. GILCHRIST

BERKELEY, CAL.

IT will be generally conceded that in the economics of an individual, his material prosperity is in direct proportion to his material wealth. This clearly reflects the ordinary meaning of the word prosperity. In the case of a nation, our first thought would be that the average or per capita wealth would fairly represent the national prosperity, but a little reflection will show that this is not the case. We can conceive of a nation in which the entire population save one were the abject slaves of that one, producing wealth of an absurdly luxurious sort for his use and consumption, and retaining for themselves the barest pittance. Here the per capita wealth might be very high, although practically the whole of the population would be on the verge of starvation. Egypt, at the time her ancient kings were building their great monuments, gives us a picture of a nation that approached such a condition. Where such inequality in distribution exists, the average wealth is no indication of the prosperity of a people, which may be estimated only by an examination into the extent of the inequality in distribution. The prosperity of any given people can not be measured by its wealth, but rather by that prosperity among its individuals that predominates. We can not think that the excessive wealth of some in any way averages up or compensates for the poverty of the masses.

There are two aspects of wealth—the property aspect and the income aspect. In speaking of property we refer to the stock of wealth, whereas income is the rate at which wealth is being acquired, as so much per day or per year. The national wealth is the sum of the wealths of all individuals and the national income is the sum of all individual incomes.¹

Income may be divided into two parts, one which is consumed and one which is saved. If the rate of consumption be subtracted from income, the difference is the rate of saving.

All income is acquired by individuals through two clearly defined and undisputed sources. These are the income from labor or services rendered; and the income from property owned. But while income is thus *acquired*, it is *produced* solely by the labor element, notwithstand-

¹ Property and income nominally held to the account of corporate bodies or governments must here be considered as distributed among such individuals as are the real owners.

ing the fact that property is a factor in wealth production. It is a factor and not a producer in the same sense that the wheels of an engine are a factor and not a producer of the energy developed, which is derived solely from the potential energy of the coal. Not only may labor produce without property, but it is the producer of property. In short, property does not produce, it is an opportunity to produce.

The proposition that all income is produced by labor will be disputed, for at once there comes to mind that portion of income that arises through an increase in land values and which at first sight can not be attributed to production by labor. But—taking land values as typical of all forms of so called wealth not directly attributable to labor—the following propositions, at least, are evident: (1) That value attaches to land solely because land ownership is the privilege, through rent, of regularly acquiring the products of labor. (2) That in a society which is economically static to the extent that land values are stationary, *all* income is the product of labor. (3) That in the long run and in the world at large *all* income is unconditionally the product of labor since history shows us that civilizations, and therefore land values, rise and fall in long period oscillations. (4) That in a country like the United States where land values are increasing, such increase is only a part of property income, the other part consisting of rent on land values and returns from other forms of capital, all of which is unquestionably the product of labor.

In the absence of property incomes, service or labor incomes could be equivalent to the wealth produced, but since property incomes absorb some of this wealth, the average of service incomes must be less than the average wealth that service produces. Neglecting for the time being that part of property income arising through increase in land values, it is evident that the dual source of income—service and property—can not apply to the national income as a whole, which must be equivalent to the national production. This is to say that the distinction between the two kinds of income is a socially internal one, some have the property income *because* others have it not. A man may receive more or less than he produces, according as other men receive less or more than they produce, but not so with the community as a whole which receives just what it produces.²

In all the figures compiled in this investigation land values are included, partly because present methods of accounting make it difficult to distinguish these from the products of labor, and partly because to raise the distinction would be to raise questions beyond the scope of our survey. But we may remember that in so far as any form of wealth

² Foreign relations are here neglected. But in 1914 the excess of our wealth sent abroad (\$470,000,000) was only about 1½ per cent. of our total wealth production for the year. To that extent approximately we were paying foreign nations a property income with our labor.

is not a product of labor, it is merely a "capitalized value" of an income consisting of the products of labor.

That the present distribution of wealth in the United States is exceedingly unequal is yearly becoming more and more apparent to even less thoughtful people. The question of the injustice in the distribution of either property or income, or of a remedy for that injustice, is not here at stake. Our purpose is to present graphically the spectacle of inequality as it exists, and its relation to our national prosperity of which we are accustomed to boast. We will first examine the distribution of property and then the distribution of income, for these correspond to the two ways in which we may think of prosperity.

There being no recent figures in regard to the distribution of property, it is necessary to content ourselves with the distribution of 1890. Fig. 1 shows in a graphic manner the distribution of 1890, but transformed so that the total wealth and population correspond to 1913. Since concentration is increasing, we may bear in mind that inequalities in distribution shown by this diagram are less than the actual inequalities of to-day. The family instead of the individual is here taken as the unit. The presumption is that unmarried adults are considered as families of one each, so that with few exceptions the total wealth of the country is represented in the diagram. Each family averages about five persons, of which two are, on the average, "gainfully employed."

The horizontal base line of the figure must be imagined as divided into 19,200,000 equal parts, one for each family in the country. The families are arranged in the order of their wealth, the wealthiest at the right end and the poorest at the left end. If over each of these minute divisions we erect a vertical line the height of which represents the amount of wealth owned by that family, the tops of these vertical lines can be connected by a continuous curved line, as shown. Since these vertical lines are arranged in the order of their length, the curved line or locus will everywhere slope up from left to right, but, aside from this, it might have any form according to the manner in which the total wealth was distributed among the families.

The striking feature of such a diagram is the fact that its area represents the total amount of wealth, and any portion of its area enclosed between vertical lines represents the wealth owned by the portion of the population that these lines intercept on the base line. The lined area, then, is the total wealth of the country, and that the great bulk of this wealth lays with the first tenth of the population is evident at a glance. Imagine the figure as a great piece of land of just that shape and of uniform fertility and usefulness throughout. Then if we divide it up by 19,200,000 equi-spaced fences, parallel to the straight line at the right end, the narrow strips so formed would be distributed one to each family, and as shown by the figure the first 10 or 20 per cent. of

the population would get practically the whole thing, while the land going to the last half of the population is a negligible share. In this mental picture we are merely taking land as typical of wealth in general.

So unequal is the distribution and so attenuated the shape of the figure, it was not possible to show satisfactorily the upper right portion of it. This limb must be imagined as extending upward to such a height that a half of the whole area lies in the right-hand strip corresponding to 1 per cent. of the population. The curve would finally meet the extreme right hand line in an exceedingly sharp point whose height would represent the fortune of the richest man in the country. Taking this at a billion dollars, the figure would have to be ten thousand times higher to show it. The pertinence of this diagram is not so much in the numerical values that may be scaled from it, but in the graphic or pictorial impression we get from the manner in which the area is distributed with regard to the horizontal base line. However, *1 per cent. of the people own more than the remaining ninety-nine!* Think of it! One half the national wealth practically crossed out as

FIG. 1. This diagram is based upon an estimate for 1890 by Charles B. Spahr. (See his "The Present Distribution of Wealth," pp. 69.) The diagram shows the wealth and population of 1913 with the distribution of 1890. It was made by projecting from one period to the other by population and total wealth. Spahr's figures thus transformed give:

Families		Total for Group
88.5% or 17,000,000 own	under \$10,000	\$27,450,000,000
10.5 or 2,000,000 own	\$10,000 to \$100,000	70,150,000,000
1.0 or 200,000 own	\$100,000 and over	100,650,000,000
100% 19,200,000		\$198,250,000,000

These data were sufficient to fix but two points on the curve, but the total wealth between these points being given, the intervening curve was drawn with just enough concavity to make the area below it equivalent to that amount of wealth. In the same way the amount of wealth for all those families owning less than \$10,000 determined the concavity of the left end of the curve. If the wealth of every family was known and plotted, the resulting curve would undoubtedly be less smooth and continuous than the one drawn, but it would follow the general trend of that curve.

FIG. 2. Figures for this diagram were first compiled for what the census calls "persons gainfully employed," and then transformed to the family as a unit on the basis of 42 per cent. of population gainfully employed, and 5.05 persons to the family. This is equivalent to 2.1 persons gainfully employed, to the family.

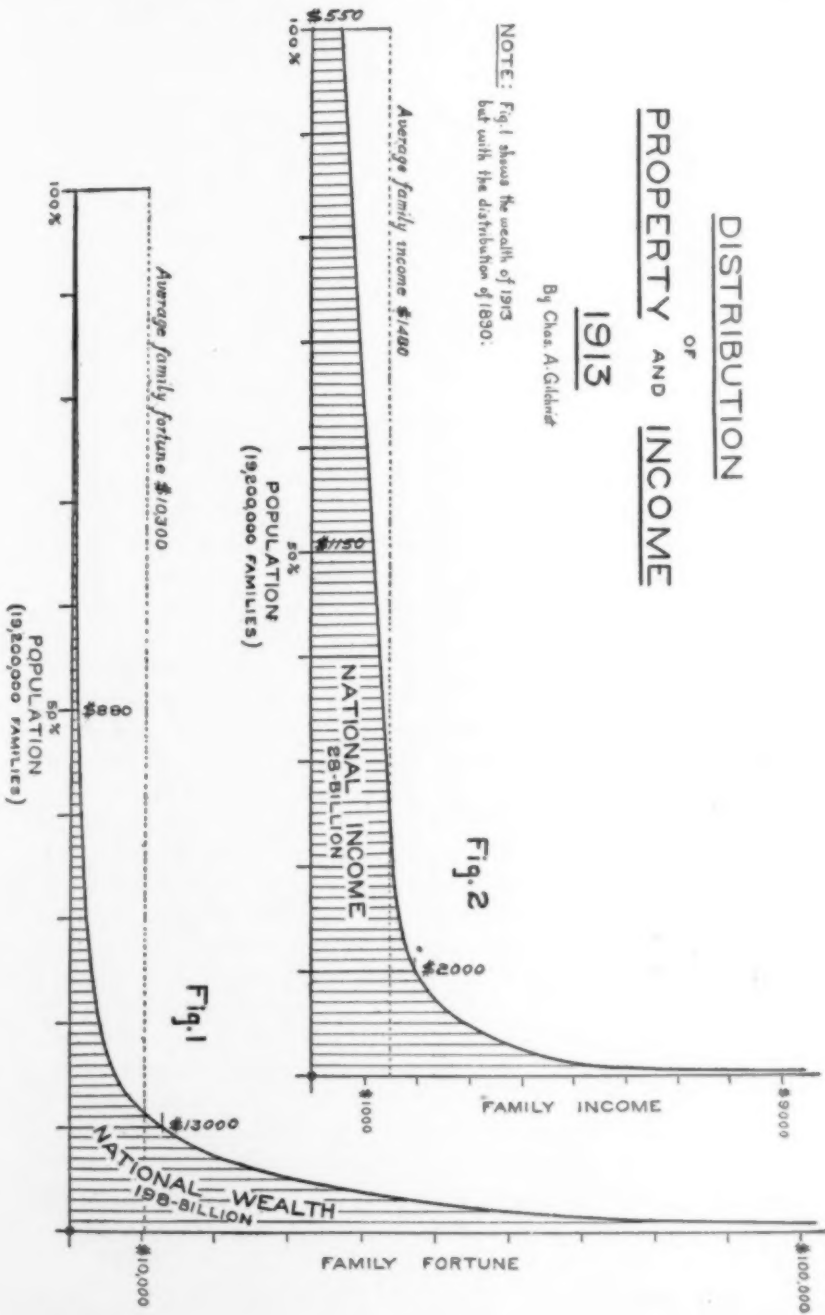
Personal incomes below \$1000 (\$2100 family income) were apportioned by figures of Scott Nearing for the year 1913. (See his "Income," pp. 106.) Incomes above \$2500 were taken from the Annual Report of the Commissioner of Internal Revenue for 1914, and increased 20 per cent. to cover omissions. (Income tax returns, pp. 112.) Incomes between \$1000 and \$2500 were allotted to the remaining population. Transformed to families, these figures give:

Families		Total Income of Group
42.6% or 8,200,000	under \$1050	\$6,600,000,000
39.7 or 7,614,000	\$1050 to 1575	10,100,000,000
9.0 or 1,720,000	1575 to 2100	3,100,000,000
7.8 or 1,500,000	2100 to 5250	4,900,000,000
.9 or 166,000	5250 and over	3,800,000,000
100% 19,200,000		\$28,500,000,000

DISTRIBUTION OF PROPERTY AND INCOME

By Chas. A. Gildner

NOTE: Fig. 1 shows the wealth of 1913
but with the distribution of 1890.



far as national prosperity goes, since it is the property of but 1 per cent. of the population! Four fifths of the people own but one tenth of the wealth!

The dotted line showing the average wealth per family is seen to be not the least indication of what families in general are worth, seeing that 70 per cent. of the families do not own even a fifth of the average family wealth. There is a big difference between the *average* family wealth and the *predominating* family wealth. The family midway between the extremes is worth about \$880 and this is perhaps as near as any one figure may come to expressing the family wealth that predominates among such enormous variations. Would not the prosperity of the nation be far more truly reflected in this middle family wealth of \$880, than in the average family wealth of \$10,300? The one is the wealth of the average family and the other is the average wealth of families. The complete failure of the significance of the average is strikingly shown by the fact that the *mean variation* from the average is \$15,500³—more than the average itself.

Turning now to examine the distribution of income, we find that it differs in a marked way from the distribution of property. Fig. 2, which is the diagram for income distribution, is constructed in precisely the same way that the diagram for property was constructed—areas represent total incomes.

Had we not examined the property diagram first, we might have been impressed with the great inequality of the income distribution. Quite a portion of the area is lost to view in the extreme height of the narrow vertical point, for the group of incomes above \$5,250 represent over 13 per cent. of the total income, and they are absorbed by less than 1 per cent. of the people. But as compared to the property distribution, we see that the distribution of income among the masses is less nig-gardly. There is not the same great gap between the average income and the income of the middle man as in the case of property where the middle property was but 15 per cent. of the average. But the mean variation from the average is very high, being about 50 per cent. of the average. The average income is remarkably low, for in all incomes were leveled up, each family would receive but \$1,480 (\$300 per capita), which seems to be about what half of them are now actually getting, although some 40 per cent. are receiving less than half as much, while the remaining tenth might be accounted from middle class to exceedingly rich. The yearly income of our richest American citizen exceeds the life-time earnings of two thousand of our average American citizens. Mr. Rockefeller's income is about \$100 a minute. His yearly income is roughly equivalent to the income of fifty average American citizens sustained through the entire Christian Era.

³ Obtained by dividing the wealth represented by the total area between the curve and the dotted line by the number of families.

From Fig. 2 it would seem probable that the continuity of change in the higher incomes was continued down to incomes in the neighborhood of \$1,600, but below that point the curve seems to change its nature, becoming much straighter. The cause of this probably lies in the fact that incomes, unlike property, can not fall below a certain minimum if life continues. This is what economists call an income or wage of "bare subsistence." For all incomes in the lower portion of the diagram the term wage, would, of course, be synonymous with income. Wages cannot fall below some such minimum because if the masses are to produce for the few, then the few must pay them at least enough to keep life going, even though they possessed the power to make them work for nothing. A man may possess power of life and death over his slave, but he will not get much out of him unless he feeds him. The nature of the horizontal limb of the curve clearly shows this principle. No such principle is illustrated in the curve for property, for a man may live without property, though he can not live without income, which makes it possible for the few to acquire *all* property. This the few actually do in a population made up mostly of chattel slaves, and Fig. 1 would seem to show that in effect this has been done in our glorious land of freedom to-day.

Although the figures and assumptions entering into these diagrams are extremely rough from a mathematical standpoint, nevertheless, the errors they involve can not affect the broad facts they display. The pitfalls of statistics do not lie in a failure to refine, but rather in a failure to interpret. Probably that group of family incomes where the distribution is least known is the group from \$2,100 to \$5,250. And the group where the distribution is best known is the group of family incomes from \$5,250 up. This is the group of individual incomes from \$2,500 up. Owing to the returns from the income tax, accurate information as to distribution in this high income group is obtainable, and it is worthy of separate consideration.

The Annual Report of the Commissioner of Internal Revenue for 1914 gives the number of persons receiving incomes in each of eighteen specified groups above \$2,500. Owing to omissions that are discussed in the report, the incomes mentioned are all less than the actual incomes, but since the omissions would apply with approximately the same proportional weight throughout, the figures lose none of their significance as far as distribution is concerned. Fig. 3 is a diagram which treats these incomes as we treated all incomes in Fig. 2. It is the attenuated vertical point of Fig. 2 brought down to a horizontal and vertical scale that will make the distribution apparent.

When we remember that the statistics bind this curve much more fully than the curves of Fig. 1 and Fig. 2, there is something very striking about its continuity. So striking, in fact, that it makes us sus-

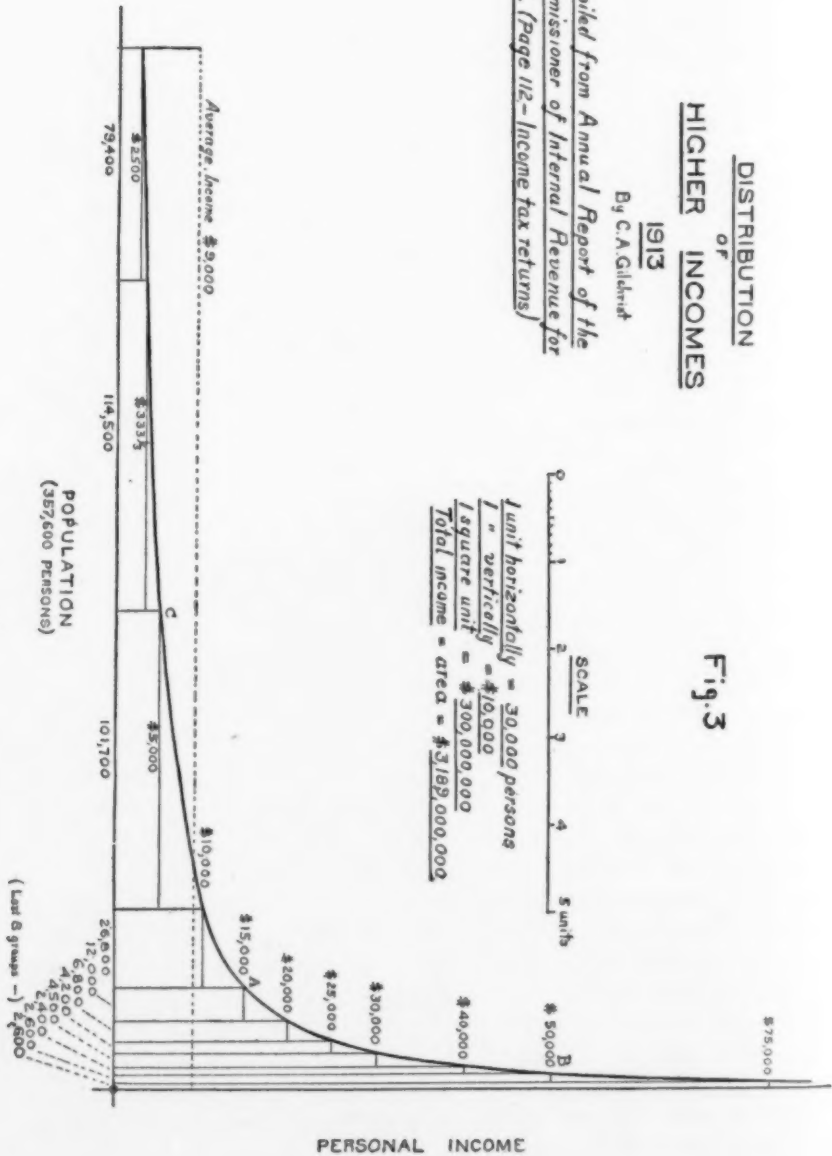
DISTRIBUTION OF HIGHER INCOMES

1913

By C. A. Gilchrist

*Compiled from Annual Report of the
Commissioner of Internal Revenue for
1914. (Page 112 - Income tax returns)*

Fig. 3



picious of some general law of incomes displayed therein. In every one of the eighteen groups the mean rate of increase of the incomes is greater than the mean rate in the preceding group. It is not remarkable that the incomes continually increase from left to right, for they were so arranged as a condition of the drawing—but it is remarkable that their rate of increase should continually increase. True, this was also the case in the other two diagrams, but the continuity of curvature was not so marked and in the case of Fig. 1 we were free to make the curve fairly smooth, since we were bound to only two points. But here we are bound to eighteen points, all of which lie on a strikingly graceful curve.* Only ten of these eighteen points are shown on the diagram, the others all lying on the vertical limb beyond the limits of the drawing. But by plotting to other scales the same continuity is exhibited in all parts of this vertical limb. No manner of plotting will show satisfactorily the full extent of both horizontal and vertical limb at the same time.

What does this continuity of curvature mean? It means that incomes increase throughout their whole range at an expanding rate. In the fourth group the rate of increase is nineteen cents per person, while in the fifth group the rate is forty-two cents per person. In the first group the rate is one cent per person, while in the seventeenth group the rate is \$2,280 per person. Or to put it in another way—a man in the seventeenth group, in order to raise his income by \$2,280, must get ahead of but one other man in the race, whereas a man in the first group must pass some 228,000 others in order to raise his income by a like amount. It all means that the greater a man's income the easier it is for him to augment it—a state of affairs curiously incongruous, since the greater his income the less need for him to augment it. But this is the principle in distribution that accounts for the enormous inequalities of property shown by Fig. 1. It is what Herbert Spencer would call an example of the law of the "multiplication of effects." Or in current platitudes, "nothing succeeds like success." It would seem to show that a condition even approaching equality was one of unstable equilibrium and that society contains within itself the seeds of economic destruction. We do not assert that such is the case for there may be other seeds in society with an opposing tendency, but such opposing forces are not now, at least, in evidence.

* The curve in Fig. 3 has the general shape of the mathematical curve $xy^2 = a$. A curve of this form was forced to pass through the three points *A*, *B* and *C* by conditioning three of its parameters. These were the position of its two axes, and the constant *a*. If for coordinate axes we take the axis of *X*, .34 units below the horizontal base; and for the axis of *Y*, a line .039 units to the left of our right-hand vertical, then the curve $xy^2 = 3.85$ so referred, will pass very close to all ten points. At the \$10,000 point it will be about .05 units too high, but at the other points the variation is too slight to show upon a drawing.

A summary of our survey points to the inevitable conclusion that the inequality of the distribution of wealth in the United States is violent beyond the dreams of avarice, and that its relation to human effort and ability is a vanishing quantity, while its relation to inequality of opportunity is most apparent.

With the opening of 1915 the wealth per capita was about \$2,200, or, say, about \$11,000 per family.⁵ But these average or per capita figures are meaningless, since the property of the merest fraction of the people approaches anywhere near the average. The inequality in distribution is such that four fifths of the people own less than one tenth of the wealth, while 1 per cent. of the people own more than the remaining ninety-nine.

The annual production of wealth or annual income is about \$300 per capita, or \$1,500 per family, or \$700 per person "gainfully employed."⁶ If we subtract from individual incomes an amount not more than enough to cover the barest necessities to physical existence, the remaining income or balance which "makes life worth living" shows an inequality in distribution on a par with that for property ownership.

The rate of saving, or rate of increase in property, is about \$107 per capita per year.⁷ Figures showing the distribution of this are lacking, but practically all the saving is necessarily with the few having the larger incomes. This follows directly from the expanding rate at which fortunes increase. If the annual addition to property was saved by the poor, then the poor would become richer and fortunes would tend to equalize instead of separate. Relative equality would then be a stable instead of an unstable state. The richer a man became the stronger the tendency to return to moderate prosperity. Such a state would be similar to all the faculties of man, such as thinking, walking, eating and so on. Any departure from the normal in these things is non-cumulative and sets up a tendency to return to the normal or healthy. And so it is with labor which produces all wealth, but not so it appears with the getting of wealth.

⁵ Pro rated from the figures for the period 1904-1912. Census Bulletin "Estimated Valuation of National Wealth," pp. 15. The figures include every form of wealth down to dealer's stocks in hand, and household and personal effects—and exclude only such extremely transient wealth as value added to food by house wife, and personal services which are consumed as fast as produced.

⁶ Persons gainfully employed includes only such as receive money for services and excludes a large class, for the most part of women whose services in house work while not translated into money value, is nevertheless exceedingly productive. The wealth created by this class is entirely consumed almost as soon as produced and since it does not enter into the circle of exchanges, it would be very difficult to estimate.

⁷ Obtained by dividing the difference of the figures for national wealth of 1912 and 1910, that is, the increase in wealth in the two years, by 2, and by the mean population for the period.

Taking the per capita production at \$300 and the per capita saving at \$100, then the per capita consumption is \$200 with the major part of the population consuming at a rate well below this figure.

In connection with saving it is interesting to note that while economists repeatedly tell us that interest^a is the reward of *abstinence* or *postponed consumption*, practically all the saving is done by those few who are already rich, and to whom saving rather than abstinence, is sheer inability to consume. It will be objected that man's desires being unlimited, any portion of even the largest incomes that is not consumed must be accredited to abstinence. But this is to say that there is no objective standard of abstinence, and without this the economics of the case becomes impossible. If the poor man who curtails his food consumption in order to lay by for a rainy day does not abstain in a far greater degree than the millionaire who goes without a steam yacht—then the word abstinence has lost meaning. It is true that if a poor man is to become rich he must begin by abstaining, but, as he becomes richer, although he saves faster and faster, he abstains less and less. That is to say, the amount saved bears no relation to the amount of abstinence. The one is no more a function of the other than the heat energy liberated by a fire is a function of the energy expended in rubbing the match that started the fire. Of the capital or permanent wealth annually saved by the nation but an insignificant part can be attributed to abstinence. Here again we see the law of the "multiplication of effects" in almost sinister operation. The less necessity for saving the easier to save. Those that are rich must become more rich, while those that are poor will just subsist. Economic life to-day seems to be of the nature of a game in which the loser and the winner do not get the gains in proportion to their ability or effort, but the winner gets *all* the gains. This is strongly reflected in the phraseology of the day in which we speak of the "game of business," or when we speak of money-making as a profession or business in itself. Just as if carpentry was one trade and money-making another. A writer on economics in justifying large fortunes says:

It is useless to decry the great American fortunes as the result of railway discriminations, extortion, oppression of labor, monopoly, etc. They are with hardly an exception the result of superior ability. We may criticize some of the methods, . . . but we can not deny that at the outset each one of Mr. Rockefeller's associates had the same opportunity to take this advantage of the railroads that he had, nor that his remarkable success shows conclusively his greater skill at the game of business.^b

The opportunity here mentioned is not to produce, but to "take advantage." The truth of the statement lies not in the justification, but in the assertion of fact, the fact that skill of the kind mentioned does,

^a Interest in the broad sense, as synonymous with property income.

^b "Economics of Business," by Edward Sherwood Mead, Chap. VIII.

under present conditions, succeed in appropriating wealth that is the product of another kind of skill. If it is true that men are justified in having what they can get with the help of their brains, then the masses would be justified in having the wealth the rich now have, if they could get it from them.

The idea that interest is the reward for *postponed* consumption is as incongruous as the idea that it is the reward for abstinence. If I postpone consumption now I must indulge it later, for otherwise it is not postponement, but relinquishment. It follows that in any considerable period of time there can be no outstanding postponement, for the postponement of some will be neutralized by others who are vindicating their postponement by consuming. No man can be said to postpone to the extent that he leaves the world with wealth to his credit, for that is relinquishment. But the national wealth is increasing. The per capita wealth in 1850 was about \$300, and now it is \$2,200.¹⁰ It means that the net saving has not come about through postponement, but through lifetime relinquishment. From the point of view of the nation we might call it postponement, but not from the point of view of the individual.

Unlike production and consumption, these things—saving, abstinence, postponement—are mere negatives, each is merely a *not doing*. They are induced solely for the purpose of fostering their opposite, which is consumption, the reality. A social science that bases its definitions on such abstractions must be illusive. Saving is undertaken for the sole purpose of furthering spending. If abstinence is undertaken for any other reason than to promote indulgence, then abstinence becomes insanity. If postponement is not vindicated, then it is not postponement. To this list should be added *scarcity*, a thing that—if we may call it a thing—has been responsible for profound confusion in economic thought.

The incomes we are discussing are, of course, real incomes, and these do not always appear in the prevalent method of bookkeeping and accounting. Thus, when a farmer produces food directly for his own consumption as well as for the market, the value of the food that he takes from his garden to his table will not appear as a part of his money income. But such value should be added to his money income to obtain his real income. The same can be said of value added by the labor of the housewife, and in fact of all wealth which is never appraised because it never gets into the circle of exchanges where relative values are measured by the standard monetary unit.

The distinction between property and service incomes, while usually apparent, is not always so. It is plain that dividends, interest and rent

¹⁰ In spite of the fact that currency prices of standard commodities fell about 44 per cent. between 1866 and 1896, prices in 1911 were at about the same level as prices in 1850. The above figures are therefore comparable.

are always a property income, but in cases where an individual who uses property is also the owner, his real income appears on its face as wholly a service income, although it arises through the two different sources. Here are two men in all respects equal, and laboring upon two properties in all respects alike. But the one rents his property and the other is an owner. The books of the one will show that rent is paid to some third party to whom the rent is a property income. But the books of the other will have no such rent item. However, his income will be larger than that of the first man by an amount equivalent to the rent and this amount of his income is a true property income *even though it is produced by his labor*. Although his labor is precisely the same as that of the first man, and applied upon a precisely similar property, yet he has the advantage in the unequal ownership of opportunity. In a utopian state in which opportunity was equally divided, it might be well to change our definitions, saying that there was no property income and that service income was the actual product of the labor. But in the present non-utopian state the distinction is a necessary one, since our customs make possible the appropriation of a part of the labor product.

Various estimates have been made of the ratio between property income and all income. Nearing estimates that from five to ten billion dollars is the amount annually *paid* to owners of property in the United States. Five per cent. on all the wealth accounted for by the Census would yield a total property income for the year 1913, of about ten billion dollars. That the mean rate on this property is 5 per cent. is, of course, an assumption. The total annual income for 1913 is twenty-eight billion dollars as listed on Fig. 2. Bearing in mind that Nearing's estimate does not include income on property used by the owner, it would probably be near the truth to say that a third of all income was property income, and two thirds service income. Other estimates have placed the property income at 40 per cent. of the total.

Beyond the fact that property incomes come mostly to the wealthy we are able to say little about the relative distribution of the two kinds of income. Among those with small income there will here and there be cases of income which is nevertheless derived from property, such as the poor widow owning a few thousand in railroad shares. And among the wealthy there will here and there be cases of large income derived from service, such as managers, corporation presidents, and famous actors and painters. We must remember, however, that many high salaries which are apparently service incomes, are in reality property incomes which take the form of high salaries in order to conceal inordinately high returns on certain properties of an unusually monopolistic nature. But on the whole the bulk of property income will go to the wealthy because the wealthy are the owners of the bulk of property.

On broad lines the difference between property income and service income seems to come back to the difference between "wages of bare subsistence" and the balance that "makes life worth living." With full knowledge of exceptions it is generally true that the property income gives a man the whole of his time, which is freedom itself, while the service income debars a man any of his time save what is absolutely necessary for rest and upbuilding, and this is economic slavery.

In these days when public opinion is correcting our morals to make a place for great individual fortunes, much currency is given to the thought that such wealth is by its very concentration a benefit to all, as well as to the owner. The thought seems to be that concentration of wealth makes investment in large scale production possible, for divided wealth would tend rather to be consumed than invested. But if this is true we reply that it only indicates that consumable wealth is more needed than capital wealth, and if it is not true then large-scale production would go on with a highly divided instead of a highly concentrated capital. The fact is that the concentration of wealth is on this very account bad, because through the curtailment of the purchasing power of the masses, it is a distortion of effective demand, and through that a distortion of the direction which production must take. Demand or purchasing power is wealth, and where wealth is concentrated there is demand concentrated. The things that will be produced are the things that the owners of wealth demand.

The benefit or advantage of a fortune is the interest or property income it will bring, and that goes to the owner exclusively. If the fortune was owned by many, then the interest or benefit would go to many. If the fortune is owned by one, then the entire benefit goes to one. The great fortune may be looked upon in two ways, one in which the owner lives frugally and reinvests most of his income, and the other in which he consumes all of his income. The first is an increasing fortune and the second a stationary fortune. In the ethics of the case the stationary fortune is alone under consideration, for whatever we may say of it may be said with still greater weight of the increasing fortune at some future time. Whatever may be said of a thing because it is big may also be said of it because it is increasing. The fact that a rich man is not consuming his income does not mean that some one else is consuming it—his frugality is no sacrifice in favor of the people.

A popular excuse for large fortunes is the current notion that they "give employment." In the ownership of opportunity it may be truly said that the rich have employment at their disposal, but they do not *give* it. They sell it at the whole value of the opportunity, and the employed gets the product of his labor minus that part of the product made possible by opportunity—he gets "wages of bare subsistence." If instead of a few large fortunes most people had a moderate fortune,

then the total of employment and opportunity would be no less, but in addition to "no opportunity wages" most people would receive a moderate property income—most people would participate in the excess of production due to opportunity. The idea that great fortunes are excusable on the grounds of giving employment is conspicuous in the writings of Andrew Carnegie. He looks upon the rich man as if he held the property of society in trust, or merely controlled it, to be administered by his higher powers of discernment. He excuses the unearned increment on the ground that the rich as a rule reinvest it, thus giving more and more employment. There is a strong tendency in the literature of the day to substitute the word control for own. The rich may control much property they do not own, but that is not included when we speak of their wealth. Even where ownership is meant we are prone to speak of a man as controlling vast properties upon which thousands are working, as if he did not actually *own* it and personally derive every possible benefit from it as much as a child derives benefit from a stick of candy in hand.

But if service incomes that actually accrue are less than the wealth produced, are they less than the wealth produced by a proportional amount? Are service incomes *proportional* to the product? In view of the great complexity of labor interchange, it would be impossible to answer this in the light of statistics. Who, for example, would undertake to say just what value was added to production by the services of a locomotive engineer? The main force tending to an irrational distribution is undoubtedly property income, so that this eliminated, we might fairly say that service incomes tend roughly to become proportional to product.

But even if we grant that service incomes are proportional to product, we must not forget that the *ability* to produce depends upon how much a man participates in property income. It depends upon leisure and education. Grant that your laborer is a shiftless sort and does not really produce more than \$1.50 a day, still, were he the possessor of a small property income, his increased income would be enough to increase his ability to produce and thus increase his service income as well. The differences in what men do produce is vastly greater than the differences in their latent abilities. That among those born in poverty to die in poverty a large portion never produce much through lack of opportunity for development of productive powers, is evidenced by the dramatic cases of one born in poverty risen to be one of the world's most productive workers, Andrew Carnegie himself being such an example. If the seeds of these high productive powers were implanted only in a very limited portion of the human stock, then we should expect the children of the founders of fortunes to be the only fortune-makers. But this is precisely contrary to the facts. The riff raff of Great Britain

go to Australia, where opportunity develops their latent powers, and in a generation they are the leading citizens of the land, while the offspring of our rich men, if they succeed in maintaining their inherited fortune at all, are notably lacking in productive powers through a surfeit of opportunity, or a lack of something which only the feeling of a little of the pinch of necessity can supply. Thus, while service incomes may approach somewhere near a distribution in proportion to the wealth that the service actually produces, such a distribution is far from just, because the deduction from service of the income that goes to property is a deduction from productive ability itself. If property were more equally distributed, *because of that* production would also be more equally distributed.

The picture we have drawn is a depressing one. It is the more depressing when we remember that the question of wealth is the most important question in men's lives. An elect few who are neither rich nor poor have solved the problem of wealth, but not so with most.

The fear of poverty makes us admire great wealth; and so habits of greed are formed, and we behold the pitiable spectacle of men who have already more than they can by any possibility use, toiling, striving, grasping to add to their store up to the very verge of the grave.¹¹

But the picture is not so depressing when we compare society as it is with what it may be.

Did you ever see a pail of swill given to a pen of hungry hogs? That is human society as it is.

Did you ever see a company of well-bred men and women sitting down to a good dinner, without scrambling, or jostling, or gluttony, each knowing that his own appetite will be satisfied, deferring to and helping the others? That is human society as it might be.¹¹

¹¹ Henry George, "Social Problems," Chap. VIII.

CAN A COLLEGE DEPARTMENT OF EDUCATION BECOME SCIENTIFIC?

BY JOSEPH K. HART

DEPARTMENTS of education in colleges and universities have been made the objects of a good deal of more or less good-natured criticism and some ridicule within recent years. For example, Professor Gayley has denied the utility of such departments altogether, declaring that teaching is "a profession that demands not so much method as scholarship and innate aptitude."¹

Professor Warner Fite, too, has taken occasion to express a rather definite view of the same sort. He says:

What the public school teacher especially needs to learn, and what the university is especially called upon to teach him, is just this—that his real efficiency as a teacher, and his ability to speak to his boys and girls from the standpoint of personal and social authority, will depend in the last analysis, not upon any mastery of the "formal principles of method," or what not, but upon the evidence in himself of a thoughtful attitude toward life.²

What such writers are attempting to demonstrate is, of course, largely true, though expressed in intolerant terms. Departments of education, as distinguished from schools of education and teachers' colleges, have not yet fully found themselves. Educational theory is, on the whole, becoming rather securely based. But in its practical outcome it does not always realize its own inner logic and, therefore, falls under the criticism or ridicule of those, who, working in older and better established fields, sometimes forget the ways over which their own subjects won to recognition, and express themselves in terms not altogether worthy of scientific men.

Dewey's estimate of the function of such departments seems more nearly correct. He says:

That some teachers get their (theory) by instinct more effectively than others by any amount of reflective study may be unreservedly stated. It is not a question of manufacturing teachers, but of reinforcing and enlightening those who have a right to teach.³

Why, then, have departments of education been criticized in this way? There are at least three reasons.

In the first place, criticism has been the fate of all new departures from tradition, of all new movements. It is natural, normal and necessary for the proper organization of the new departure and for the prun-

¹ "Idols," p. 138 ff.

² Fite, in *The Nation*, Vol. 93, p. 207-8.

³ Dewey, "Psychology and Social Practise."

ing off of all extrinsic and useless elements and characteristics. Any innovator must expect and must welcome this treatment.

In the second place, the department has inevitably inherited and brought into the university some of the flavor of the normal school, and has suffered somewhat from this fact. Originally, in many schools, the department went under the name of "Pedagogy," and this "blight" has not yet been completely cured. The significance of this will appear in the next statement.

In the third, and most important, place, the department of education has been severely criticized because it has not, everywhere, fully caught the spirit of science. The spirit of the modern university is, on the whole, scientific. The department of education is one of the youngest of university departments. Coming into the university by the sufferance of the older departments, its place in the university must depend upon its ability to win the respect of these other departments, in which the spirit of science largely prevails. This has not always happened.

In some of the larger schools of education and teachers' colleges extensive differentiation of work and a considerable development of the spirit of inquiry have appeared, at least in certain lines. But in the colleges and universities where this work is still carried on within a department, there is large foundation for the suspicion that little work of a genuinely scientific character is done. It is probable that a thorough inquiry would reveal similar conditions in many departments which pride themselves upon their scientific standing. But that is aside from the point. Our question is: Can a college department of education really become a scientific department?

This question takes two directions: first, what is the real work of such a department? and second, can such work really take upon itself the scientific spirit? These are, however, not two distinct problems: the first suggests two answers and appeal must be made to the second for a decision as between these two.

What, then, is the real work of the college department of education? The two answers, suggested above, may be called, without invidious distinction, the intellectual and the social programs in education. (Such a distinction appeared in a recent discussion of this subject among a group of teachers of psychology and education in certain colleges and normal schools.)

The answer, which is here called intellectual, seems to conceive the educational situation somewhat as follows: The school exists as a fixed institution having the task of training the children of the community. The curriculum of the school is pretty clearly defined; the methods are, in the main, well worked out; the constructive principles to be obeyed are in the books; the machinery of administration and control is established and in working order.

From this point of view, therefore, the work of a college department of education will be the training of teachers to fit into this existent school situation. Such training will linger long on such courses as the "Principles of Education," "Methods," "Child Study," and the like; with, if possible, some practise work in the school system. In all of this the effort will be made, in very sympathetic ways, to help the prospective teacher realize the conditions of school-room procedure, and the appropriate ways of doing things under all circumstances. A course in the history of education may be offered, or required, but, if so, its function will be largely informational. So, also, courses in the social aspects of education or theory of vocational education, and the like, may be offered; but these will be for the purpose of making sure that the prospective teacher knows what is going on, and is properly fortified with arguments against the educational fallacies of the age.

In it all there will be little, if anything, deliberately intended to stir the native hue of intelligent resolution in the prospective teacher and make him feel his own creative and constructive responsibility in the educational tasks of his community. The argument will even be advanced that children must have a larger freedom of opportunity and initiative in education to-day; that the school must learn how to offer this greater freedom; and that therefore the teacher must have a more complete training. But the training must be of this "safe and sane" sort: it must acquaint him with assured results, so that he will fit into the institution.

Or, if there be some work offered in the field of experimental education, it partakes largely of the nature of the alchemy of the middle ages. It is pseudo-scientific. It looks for curious facts. Assuredly, it is not for the purpose of stimulating such a spirit of intelligent inquiry as might make the student independent of the teacher—a free citizen of the realm of science.

That is to say, the whole effort of departments of education organized from this point of view is traditional, rather than scientific. Their spirit is really that of the old time normal school—wherein teachers learned how work was to be done: the knowledge was existent; the student "took it on."

But what is the real spirit of science? Whatever else it may be for other departments or in other fields of life, in the field of the training of teachers, science can mean but one thing: the development in the prospective teacher of the spirit of inquiry and the method of the investigator. This will involve the growth of knowledge, of course; but it will be knowledge, not as an esthetic possession, but as a tool of analysis of the community's life and need. It means not mental certainty and satisfaction, but mental alertness and the open mind.

Is it possible to organize a program for a college department of

education that will develop this outcome? Such a program, set over against the intellectual and traditional one described above, may be called social, and will, of course, be worthy of the name of science. And this outcome can be secured.

Such a program will accept the propositions that the pupils in the schools must have a larger freedom for constructive self-activity and creative self-expression; and that teachers must be prepared to organize schools that will provide such opportunities. But such a program will recognize this fact, seemingly overlooked by the traditionalist, that the teacher, who is to provide freedom of initiative for pupils in the schools, may rightly claim something of the same freedom of initiative while in preparation; that, therefore, the work of the department of education, instead of being more rigid and fixed, should be more open and free; planned, not to *finish* the student's mental life with fixed answers and final attitudes, but to make that mind more alert, more independent, more able to recognize problems, more capable in the raising of new questions, more able to discern the valuable from the trivial, more efficient in the analysis of conditions and in the selection of solutions. In a word, the department of education will aim to secure in its students (who are to be the teachers of the future) the development of the powers of effective, analytic, and constructive thinkers. Angell analyzes this power as follows:

Our effectiveness as practical reasoners (or theoretical reasoners, for that matter) will depend then, first upon the skill with which we succeed in *conceiving* the problem correctly, and second, upon the speed and accuracy with which this conception suggests to our reasoning processes the recall of the special ideas appropriate to the case at hand.⁴

A department of education that wants to be scientific will, then, train its students to look for *problems*, not *answers*; for the growing educational situations, not the finished conclusions; and for the larger and inclusive conditions of education, rather than for the finished details of a traditional educational craftsmanship. Science believes in intelligence: when the problem has been clearly stated and conceived, the solution is not far away, and can be expected to follow in due time. It is not the business of the teacher to supply *answers*; enough that he helps the pupil to grasp the problem!

The purpose of the department, therefore, ought always to be to stimulate the mental life of the pupil (the future teacher) rather than to deaden that mental life; to release the energies, the imaginations, and the deeper appreciations of the student rather than, by cramming the student with the results of investigations in various lines, to make his mind more sodden and inflexible. For the purposes of this problem-developing type of training, four general introductory lines of work, which have a certain logical relationship to each other, are possible.

⁴ Angell, "Psychology," p. 281.

According to this social program, the first line of work to be taken by teachers in training, should be a course in the history of education. This will be, not a course of the traditional kind, wherein a long series of historical events is considered. It will be a course, not for the purpose, primarily, of coming to know the history of education; but for the purpose of uncovering the roots of the present problems of education and getting a genuine perspective of those problems in their historical development. For, history is not ended, and we are not at the end. We are in the very midst of the history of education, with problems all about us, with tasks all unfinished, and, if we could but see, with the need of programs and reconstructions that will run ahead into the far future.

The large problem of education is the making of new educational history. The real reason for studying the history of education is that one may learn how to become a maker of history. For this purpose, history must awaken the mind of the student to the problems, forces, and conditions of the present; and its outlook must be towards the future. Such a course will have scientific validity in that it will seem to the student to be the consideration of real problems and it will make him more alert and awake to realities, not merely of the past, but of the present and the future. He will finish the course with a sense of the problems of education that he must meet.

Upon the basis of such a digging up of problems, it is possible to build up a course that will organize all these problems, institutions, forces, and conditions of the present into what will be a cross-section of the history of education, to be called "The Social Aspects of Education." Here will be raised the questions of the social sources of the experiences of children; the nature of community life within which these experiences go on; the elements that may be lacking or exaggerated in the life of the community; the relationships of our social institutions to the development of intelligence in children; the place of industry and the industrial organization; of play and the play life, of religion and religious institutions, and all the other social forces in the actual education of children.

It will raise the question as to the real work of the school in the light of its historical development, and in the midst of other social institutions. It will develop the problem of the community's own education, and the part that the community's general life plays in the education of its boys and girls. And it will, finally, develop the universal problem, "why does so large a part of our school-inculcated intelligence fail to make any useful connections with the actual life of the community?"

This last question will set the problem for a third general introductory course. That problem, stated more fully, is this: How can we de-

velop an intelligence that is predominantly social, rather than, as at present, intellectual and remote? This problem seems the task of a course in the social psychology of education. We have to-day many psychologies of education. Some of these are merely moralizing restatements of old analytic psychologies. Others are socially useless statements of the results of modern laboratory research. An experimental chapter on memory is a valuable piece of work, and should be found in this social psychology—as a sort of footnote. This social psychology will be conscious of the social source of all educational experiences and it will look ahead to their social outcome. It will make use of laboratory results in stating the pure mechanics that may be needed in the processes of training. This will give meaning to laboratory material, most of which is confessedly of no use at present to any teacher—from which, indeed, teachers have been rather severely warned—and this use of laboratory material will save analytic psychology from mere moralizing.

Beginning with the social conditions of experience and keeping always in mind the social outcome of experience, such a course as this should work out the main psychological pathways by which children may be assured a gradual development of a genuinely intelligent experience, without at the same time losing the social quality, either of their experience or of their intelligence. This course, therefore, ought to offer to the student an effective psychological instrument for the analysis in social terms of the educational problems that will present themselves in the school room and community.

In the fourth place, there should be required of all students who expect to teach, a constructive course in the social principles of education. This will probably involve either previous experience as teacher or parallel work as practise teacher. In this course the students should do all the work. The teacher's function will be merely to keep constantly fresh, and stimulatingly active before the minds of the students, the question: "What shall be my program as a teacher in the school?" The history of education has given the perspective of present problems and conditions; the social aspects of education have given the broad, social outlook and the conditions within which the program of education must go on; the social psychology of education has analyzed, as much as may be, the methods and processes of a social intelligence. And on the concrete basis of previous experience or present practise, the student should now work out a constructive outline of his intended program as a teacher. This program should consist of the student's own individual organization of all his previous training, experience, study and intelligence, into a hypothetical plan which will sum up his present understanding and determination.

In this course, he should become conscious, as never before, of the

social background of his future educational work and of the significance of human culture and the educational sciences for his methods and program in the school. He should be able to say, at the end of such a course, that he has found *himself*, not merely his teachers, or some books, and book answers. The principles which he carries away with him should be his own, wrought out in his own intelligence, and expressing his own capacity for service in the world.

This program, the expression of his own personality, should enable his instructors to determine more definitely his probable value as a teacher: whether he has, or can attain, that actual intelligence and power of performance which will make him a constructive force in his future school community, able to *recognize and analyze problems*, capable of self-expression and initiative, and therefore capable of welcoming and developing the self-expression and initiative in the children whom he is to teach.

There will be many other particular phases of the field of educational theory and practise which the prospective teacher will want to investigate: advanced work in theory, principles of administration and supervision, special problems in psychology, and various aspects of the social side of educational development. These should be provided for with such freedom as will permit the further extension of the student's intelligence into the eventual sense of mastery of education as a social function.

There is another aspect of the work of such a department to which attention must turn for a moment. This is the field of constructive research work, for the most part the task of the instructors in the department, with perhaps the help of advanced graduate students. From the point of view here presented this research work is inseparable from the work of training prospective teachers. At the present time, or up until the present, research work in the field of educational theory has been largely devoted to the special investigation of problems in psychology. It has seemed that this part of the field was the only part possessing sufficient scientific dignity to warrant reputable research.

But this would seem to be a mistaken view. The great field of research in educational theory may yet come to be found in the social sources of educational experience. Let this be illustrated concretely. Education is a social function. It begins with the children of the community, it proceeds in the midst of the community, its outcome is to be the community of the future. Not all of education goes on in the school. President Wilson's recent statement that "the government can not generate thought" is true also of the school: the school can not generate thought. Experience, thought, emotion, appreciation: these are all *social* products, not the products of the schools. At the best the schools can create the conditions under which these products appear, and can criticize them, and organize them as they do appear.

What, then, are the resources of the community in these directions? Just as the geologist surveys the state, looking for its possible supplies of mineral wealth, or just as the forester searches out the remote resources of lumbering wealth, so the educational research men of the future will explore and survey the state for its hidden wealth of moral energy, youthful idealism, social purpose and individual promise hidden in village or city homes, working in quiet ways in the making of better communities, struggling with the untoward elements and crudities of social life everywhere. The state is rich in these hidden resources: men and women, especially young men and young women, and groups of all these, who are working with zeal and hope, yet with much indirection, for larger and better things. The school must get over its academic tradition and get into an attitude of mind that will enable it to understand, appreciate, and give really intelligent direction to these partial movements. *These* are the real educational resources of the state. Here the future teachers will find their problems, their inspirations, and, if they have been trained to the development of a native intelligence, the tasks of life.

These are the real problems of educational research. How can our schools make organic connection with the educational hopes and purposes of their own local communities, and bring to those communities the intelligent direction that they lack, that they long for, that they must have, yet of which they are self-respectingly and narrowly suspicious? How can these things be done? These are the tasks of that larger educational research that is opening before us, to-day. Here open the problems in educational psychology, not of the dry-as-dust sort, but of the vital, social sort, whose results when found will have significance for education elsewhere. Here are the calls for long and intelligent consideration by all the men and women who can be found. And results attained in these fields will have scientific value, social value, and practical value in the training of teachers.

Other aspects of this problem should be presented, but these phases of it show the scientific possibilities hidden in this field. Such a program of teacher-training, and educational research might win for the department the scientific standing that it longs for among the departments of the university or college. At any rate such a program would indicate that the department had caught something of the spirit of real inquiry, the real spirit of science, and that it could really become scientific.

NEW JERSEY'S INSECTS

By HARRY B. WEISS

NEW JERSEY AGRICULTURAL EXPERIMENT STATION

INASMUCH as the number of species of insects inhabiting the earth is far greater than that of all other animals grouped together, it is hardly necessary to state that New Jersey's 10,530 species should not be taken as an indication that this state is an undesirable place in which to live. Other states have just as many, if not more. As the presence or absence of insects within the borders of a community or state may be responsible for the difference between sickness and health, irritation and comfort and poverty and wealth, the following questions naturally arise when such a large number of species is considered. Are all of them injurious? If not, of what use are the others? Are any of them beneficial and so on.

The following tables compiled chiefly from Smith's "List of the Insects of New Jersey" and other papers dealing with the insect fauna of that state will serve to answer these questions. Ten thousand, five hundred and thirty is the number of species which has been recorded up to the present time. Many others, principally in certain obscure groups, remain to be found, but, on the whole, New Jersey has been rather well collected over and the above number is fairly representative. The eight divisions used are those in which the species naturally fall. It would be possible of course to have a larger number of groups, but for a clear and quick understanding, a few only are desirable. Those insects whose habits vary considerably in the different stages have been placed according to their predominating mode of life.

The first group includes those of little or no economic importance, such as species of the *Corrodentia* which feed principally on lichens and moss, and the aquatic forms found in the *Plecoptera*, *Ephemera* and *Trichoptera*. The second includes various species which infest stored products, food and otherwise, and those commonly known as household pests. The scavenger and third group embraces the feeders upon the products of decay, dead or dry animal and vegetable matter, and those which change or remove the form of animal and vegetable remains and aid in reducing such substances into shape for assimilation by plants. The fourth division consists of those which annoy, irritate or transmit diseases to vertebrates, while the fifth takes in all which are predaceous upon other insects. Those which feed upon liv-

ing plant tissue, many of which are of direct interest to the agriculturist, will be found in the sixth group, the insect parasites in the seventh and the beneficial plant feeders or pollenizers in the eighth. It would be possible of course to include in the eighth group, certain members of the Diptera, Coleoptera and Lepidoptera which as adults serve a useful purpose as pollenizers, but, on the whole, such species have other predominating larval habits which overshadow the beneficial ones of the adults.

Table I. shows how the different orders are represented in each group.

TABLE I

Order	1 Of No Eco- nomic Importance	2 Injur. to Stored Products	3 Scav- engers	4 Injuri- ous to Verte- brates	5 Preda- tory	6 Injuri- ous to Vegetation	7 Para- sitic upon Insects	8 Bene- ficial Plant Feeders	Total No. Species
Thysanura.....		3	38						41
Ephemera.....	29								29
Plecoptera.....	25								25
Mallophaga.....				101					101
Isoptera.....			1						1
Corrodentia.....	36	2							38
Platyptera.....	9								9
Neuroptera.....					44				44
Mecoptera.....					11				11
Trichoptera.....	60								60
Odonata.....					121				121
Thysanoptera.....						14			14
Parasitica.....				13					13
Homoptera.....						507			507
Heteroptera.....				2	142	269			413
Dermoptera.....	5								5
Orthoptera.....		3			9	140			152
Lepidoptera.....		4	25			2,091			2,120
Coleoptera.....		44	1,161		696	1,207			3,108
Siphonaptera.....				4					4
Hymenoptera.....		2	118		302	362	1,012	211	2,007
Diptera.....			475	133	357	485	257		1,707
Totals.....	164	58	1,818	253	1,682	5,075	1,269	211	10,530

TABLE II

	Per Cent.
Insects of no economic importance	1.55
Insects injurious to stored products	0.55
Insect scavengers	17.26
Insects injurious to vertebrates	2.40
Predatory insects	15.97
Insects injurious to vegetation	48.19
Insect parasites	12.05
Beneficial plant feeders	2.00

Table II. indicates the percentages of the different groups. Thus 17.26 per cent. of all the species found in New Jersey can be classed

as scavengers, these being found principally in the orders Coleoptera and Diptera. Belonging chiefly to the Mallophaga and Diptera, we have only 2.40 per cent. which are injurious to vertebrates, among which however are species closely associated with man and disease. In the Coleoptera, Hymenoptera and Diptera are found most of the predatory forms, amounting to 15.97 per cent. These, of course, are engaged in feeding upon and destroying those of their kind and others which might be more or less beneficial. The largest percentage, 48.19, consists of insects which injure vegetation and is made up chiefly of species from the Lepidoptera, Coleoptera and Homoptera although some of the other orders are fairly well represented. In the parasitic group, the 12.05 per cent. is found solely in the Hymenoptera and Diptera. Classing the scavengers, the pollenizers, the predatory and the parasitic forms together, we have a total of 47.28 per cent., a number which almost equals the percentage of injurious ones. Thus it is seen that almost one half of the species of insects which we have in our midst are engaged in useful activities.

Considering the injurious ones from another viewpoint, namely, that of destructiveness, it is surprising how small a proportion is destructive enough to warrant the application of insecticides or remedial measures. The following table (III) gives the total number of species in the seven most important orders and the number and percentage of destructive ones. It must be remembered, of course, that there are numerous other species classed as injurious, but these do not occur in sufficient numbers to make their presence felt or they confine their attentions to unimportant plants and are therefore not included in the list.

TABLE III

Order	Total No. Species	No. of Destructive Species	Percentage of Destructive Species
Coleoptera	3,108	50	1.60
Lepidoptera.....	2,120	58	2.73
Hymenoptera.....	2,007	9	0.44
Diptera.....	1,707	28	1.64
Heteroptera.....	413	8	1.93
Homoptera.....	507	28	5.52
Orthoptera.....	152	5	3.28

Of the entire number of species listed from New Jersey, 10,530, which includes all orders, only 1.76 per cent. is really destructive. Of the entire number in the seven orders in Table III., only 1.85 per cent. is destructive. As to the individual orders, the Homoptera have the largest percentage and the Hymenoptera the smallest, which is not strange considering the fact that all of the members of the Homoptera are plant feeders, while the Hymenoptera consist of both beneficial

and injurious forms, with the former largely in the majority. The Orthoptera with its 3.28 per cent. of destructive species contain a large majority which feed upon vegetation. While most Lepidopterous larvæ feed upon vegetation, yet the fact that many confine their activities to plants not under cultivation by man or occur in small numbers, brings the percentage down to 2.73. The Heteroptera are plant feeders with numerous exceptions; predatory and injurious insects are abundant in the Coleoptera and the Diptera contain predaceous and beneficial species as well as feeders on animal and vegetable tissue. In these three orders, the percentages of destructive species are similar.

Therefore, the insect losses in the state of New Jersey are due entirely to the activities at different times of only 186 species, some of which are and any one of which may become notably abundant.

THE HISTORICAL CONTINUITY OF SCIENCE

BY PROFESSOR T. BRAILSFORD ROBERTSON

UNIVERSITY OF CALIFORNIA

Yet I doubt not thro' the ages one increasing purpose runs,
And the thoughts of men are widened with the process of the suns.

—Tennyson.

FROM the time that man first entered upon those labors which were to earn him that rich heritage of civilization which we own to-day two groups of objects presented themselves to his senses and his intelligence, each demanding, for sheer self-preservation, the closest study his intellect could furnish. The one group comprised his fellow-men, the other the sum total of objects and phenomena which comprised his non-human environment. From the study of the former group arose the juridical and political institutions of man, while from the study of the latter group arose his religions and his science. The motives urging him to these studies were the primeval instincts of self-preservation and curiosity, but unanticipated advantages accrued therefrom to the most successful students; from the first group of studies sprang the conquest, subjection and exploitation of less gifted or less fortunate members of his species, while from the second group of studies sprang the conquest and the interpretation of nature.

In one of his classical essays Huxley, for the purpose of expounding and illustrating the methods employed in his chosen field of investigation, has told us the story of Zadig, an illustrious philosopher and astrologer of ancient days, who by the minute observation and comparison of facts which were at first sight unrelated, was able to trace and restore to his imperial master the favorite horse and dog, the loss of which had constituted a national calamity the magnitude of which may well be imagined. But the illustration which was thus employed by Huxley to describe the methods of investigation employed in one particular field of scientific research might equally well have been employed to illustrate the discipline of thought in any other field of investigation. *Observation, comparison, deduction and trial* the success or failure of which inspires and directs further observations which form the starting-point of a new and wider cast of his net into the sea of the unknown, these are the successive steps in the discipline of thought which has slowly and inevitably led man from helpless dependency upon the caprice of nature to the present day when his words travel with the speed of light and his instruments pierce the depths of interstellar space.

The historical continuity of science and its origin in curiosity and the instinct of self-preservation seem in general to have been overlooked by scientific investigators and historians of science, and there are even certain authorities who, in complete forgetfulness of the fundamental canon of the scientific method enunciated by Newton, have urged that science can not be said to have begun until "laws of nature" had been formulated and the "causes" of phenomena ascertained.¹ But that is to invert the real evolution of scientific thought. As man's field of observation and comparison grew wider his deductions grew wider, until at length they became bounded only by the limits of the visible universe, but deductions are not knowledge, inferences are not science, they are merely implements which we wield for the further attainment of knowledge, the incitements to further research.

From the earliest dawn of history we find man formulating universal generalizations which he has deemed laws of nature. His intellect demanded knowledge which his feeble powers were not yet fitted to attain, so by a simple extension of the method of anticipating results which he employed in investigating the minor details of his accustomed environment, he launched out into the infinite and anticipated the totality of phenomena. These deductions formed the dogmatic bases of his religions, and since from their very nature they could not be subject to the control of trial to which his less exalted generalizations were required to submit, so trial became taboo and the acknowledgment of impotence was deferred by making a virtue of necessity and faith an attribute of piety.

But, our scientific historian may here exclaim, our laws of nature are true, and the fantastic imaginings of primeval man bore no necessary relation to fact. I would reply that all truth that is known to man is relative and that primitive religion bears exactly the same relation to fact, upon a narrower basis of knowledge, that our laws of nature bear to our wider knowledge of fact. They were the best generalizations that the profoundest and most inspired intellects of their age could form upon the basis of their then knowledge of the universe. Our generalizations represent no better efforts or manifest superiority of our intellect, they are the fruit of wider opportunities, but they do not therefore necessarily constitute the truth. There are certain curves well known to mathematicians, which, while they continuously approach a straight line, yet no matter how far we may trace them, short of tracing them to infinity itself, never actually attain the line. So with the knowledge of man; it is asymptotic to the Absolute, and continuously approaches but never attains the truth. Thus, while I do not deny that the law of the conservation of energy bears a closer relation to objective reality than the cryptic utterances of the Delphic oracle,

¹ For example, E. Ray Lankester, "Degeneration, a Chapter in Darwinism" in "The Advancement of Science," London, 1890.

yet the very universality of the generalization sets it apart from the actual knowledge, acquired of our senses, and places it in the realm of super-sensual belief.

Belief is not science, but the beliefs of man and the science of man are destined to develop as they have developed in the past, side by side, products of the same instinctive need, often apparently antagonistic because they approach the same infinitely distant goal from widely divergent angles. But as science asymptotically approaches the infinite, so will religion approach science, until, when the intellect of man shall become commensurate to the totality of being, the two modes of interpretation will find at last their meeting-place in regions infinitely remote from the little knowledge of our day.

When we look back to the dawn of history and of written science we find man already advanced to a very comprehensive understanding and control of his environment. His conceptions were embryonic in comparison with ours, just as ours are but the germ from which will spring the ripe fruit of the knowledge of a thousand generations hence. Nevertheless in climbing the barrier which separated him from the Absolute, man at the dawn of history did not have to start from the level of utter ignorance and impotence. Far from it, for he had already attained a wide and inspiring outlook which only appears narrow to us to-day because we are vouchsafed an outlook so vastly more comprehensive that our larger perspective diminishes the vision of our ancestors to the dimension of a negligible proportion of the area which is now unfolded to our view. But in all the achievements of man "*c'est le premier pas que coûte*" and we, whose achievements will appear to our descendants so pitifully puny, can not afford not to pay our meed of profound respect to the accumulated product of the primitive facilities and unremitting toil of those who after all are removed from us in time by but an infinitesimal moiety of the eons which have been consumed in the accomplishment of our development.

Let us endeavor briefly to retrace a few of the most significant steps by which man attained that degree of knowledge and control of his environment which permitted the foundation of barbaric empires, the rise of which marks the dawn of recorded history.

The first essential step in this laborious ascent was the development of the tool. With his hands aided only by intelligence man could accomplish little more and in many directions of his endeavor less than many of the organisms which were directly or indirectly his competitors in the struggle for existence. Those concatenated reflexes which we term instincts were very much less elaborately developed in man than in many other inhabitants of his environment, a fact which was ultimately to his great advantage since his simple and primitive instincts were, by reason of their comparative simplicity, flexible and

adaptable to the vast variety of material and social environments in which man has by turns found himself situated. But in the early stages of his struggle for the mastery of nature the lack of elaborate instincts, such as those which enable the social hymenoptera to achieve such prodigies of skill and organization without the necessary exercise of any intelligence whatsoever—the lack of these placed man at a definite disadvantage. Physically not of the most powerful type and unassisted by elaborate instincts, he was compelled to supplement his deficiencies by the superiority of his intellect. Extension of his physical powers was the first prerequisite for supremacy, and this extension was afforded by the invention of the primitive tools, piercing, cutting, hacking, grinding and pounding instruments which multiplied the effectiveness of his physical powers by many thousand-fold.

The origin of the primitive pounding and grinding instruments is not far to seek, the first glimmerings of associative memory sufficed to provide us with these, as witness the fact that many animals and birds employ them. The cutting, piercing and hacking instruments demanded much more accurate observation, comparison, deduction and trial for their elaboration. In the beginning fortuitously encountered, the chance supply of ready-fashioned instruments would speedily be exhausted, and then it was that true inventiveness was called into play. First it must have been observed that certain types of stones yielded sharp edges while others did not, then that blows upon these stones produced cleavages and that some of these cleavages were sharp-edged and others were not, and finally by incessant trials sustained by inexhaustible patience and unflagging acuteness of observation, the correct type and direction of blow was ascertained which would yield a satisfactory instrument, a stone axe or an arrow-head, with an expenditure of time and labor which, although from our present point of view immense in proportion to the result attained, was nevertheless practicable and infinitely valuable in its outcome.

The first reliable hunting instrument must have been the spear and doubtless in many instances, as in the case of the living survival of neolithic man, the Australian aboriginal, the effectiveness of the spear was aided by throwing it at the object which was assailed. The customary killing of large animals yielded three very important results, first it increased the supply and variety of available food, secondly the skins (first assumed probably in imitation of the animals slain, in the performance of some obscure totemic rite) afforded clothing and increased enormously the possible geographic range of man, and thirdly the use of the sinew was discovered.

The utility of the sinew as a means of tying and binding may have been largely a fortuitous discovery, but what are we to say of the discovery of the bow? It should be observed that the bow is useless until

it is complete. The spear or arrow may be imperfect and yet admit of being impelled towards its object, but the means of impulsion embodied in the bow must have been completely developed and its purpose foreseen before its enormous utility could by any possibility be demonstrated. When we reflect upon the limited facilities and pitifully imperfect instruments of primitive man, upon his almost utter lack of experience of propelling instruments or indeed of any other kind of instruments, and of the conservatism imposed upon him by tribal ritual, we must I think admit that the discovery (or perhaps repeated re-discovery) of the bow is an unassailable proof of the existence among our primitive ancestors of men the creative vigor of whose intellect and capacity for taking infinite pains could not be surpassed by any of the investigators and inventors of our own epoch.

The power of man as a destructive agent was enormously enhanced by the discovery of the bow; no proportionate increase in destructive power was ever to occur again in his history until the day of the discovery of gunpowder. But power to destroy was not enough, the power to create was needed to supply its complement. Unchecked destruction implied ever increasing labors of the chase and automatically enforced a limitation to the human population of any given area, as happened, for example, in the areas inhabited by the North American Indian. But side by side with the rise of man's destructive power arose his constructive abilities, and it is in the means he chose and the success he achieved in his endeavor to provide a certain and predictable supply of animal food that we recognize some of the most striking evidence of the flexibility and adaptability of the intellectual weapon which he had begun to fashion for the conquest of nature.

The domestication of animals demanded minute observation of their habits in order to acquire that sympathy with their requirements which was an indispensable factor of success, and this knowledge acquired, the patience which was exerted in applying it must have been of an order which in our age of facile mediocre accomplishment is seldom displayed elsewhere than within the laboratory of the scientific investigator.

Returning again to a considerably earlier period in the history of primitive man, the discovery of the means of producing and the art of utilizing fire must have demanded abundant employment of observation, comparison, deduction and trial. I have elsewhere endeavored² to reconstruct in imagination the train of events which culminated in these discoveries. In the first instance the discovery of fire was probably fortuitous, but the number of factors, friction between the right types of surfaces, the presence of tinder of the requisite inflammability, the assistance of combustion by a current of air, while insufficiently

² "The Universe and the Mayonnaise and other Stories for Children." London and New York, John Lane, 1913.

large to preclude a not infrequent inadvertent assemblage of favorable conditions, was nevertheless sufficiently large to render their control at will a scientific problem which, to man at this stage of his development and facilities, must have been one of very formidable dimensions. We only know that it was surmounted, perhaps not once but many times. The laborious individual steps and the flashes of intellectual insight which led up to the conquest are necessarily lost to us forever.

If any of my readers is inclined to think that I place too high a valuation upon the intellectual exertions of primitive man, let him but try, as the author has done, with the powerful assistance of a modern jack-knife and all the inspiration afforded by familiar models, to make a practicable fire-stick or a bow and arrow which shall be something more than a toy. At the end of a few hours or days of endeavor he will have acquired a very enhanced respect for his ancestors.

The development of agriculture in its earliest stages called for foresight and prudence, but not, perhaps, for such extreme exertions of investigative ability as the inventions upon which I have hitherto been dwelling. Directly it passed the first stage of collecting edible plants in a convenient neighborhood, however, the development of agriculture demanded its share of observation, comparison, deduction and trial. The relationship of moisture to the growth of plants would be observed by a comparison of relative growth in different localities or patches of the same locality. In the neighborhood of rivers this would lead to irrigation and that in turn to the acquirement of some of the fundamental notions of hydromechanics. It would be observed, for example, that water would not flow up-hill except under pressure, that a "head" of water was capable of exerting pressure, that the water in two connected vessels tends to reach the same level in each, etc. The transition from a recognition of these principles to the formulation of the erroneous but exceedingly useful doctrine of the incompressibility of fluids required only the incorporation of mathematical conceptions which were destined to be the bye-product of the apparently unrelated enterprises of astronomy and architecture.

The development of architecture is generally traced from the tent of skins and the cabin of logs. Directly more ambitious edifices came to be attempted, however, a knowledge of the strength of materials and the relationship of stress and strain to structure became an imperative prerequisite of success, and by the now familiar process it was acquired. As the constructional details of a large edifice were too numerous to be simultaneously borne in mind, design became a necessary part of architecture, and geometry sprang from design.

The stars must necessarily have riveted the restless curiosity of man from a very early period in his development. Their utility as landmarks and as guides must speedily have impressed themselves upon

migratory people, and this would lead to a recognition of the periodicity of their apparent motions. These periodic changes, beginning with those of the sun and moon (leading to the conception of the day and month), laid the rude foundation of a calendar, the utility of which to the political leaders and organizers of mankind speedily became so evident that the calendar has from the dawn of history been regarded as an important preoccupation of government. From this sprang the early importance of the astrologer in the eyes of the state, more especially as the interpretive fertility of man's imagination had from an early period sought causes for the majestic harmonies of the skies, and these causes, so remote and so all-powerful, were well qualified to arouse the awe and veneration of mankind and an acknowledgment of man's impotence before the mighty forces of the universe and his respect for those whom he believed qualified to interpret the manifestations of this supernal power.

Under what circumstances and by what stages arose the primitive methods of isolating metals from their ores, of mixing them in the requisite proportions to form alloys possessed of properties differing from those of either constituent, and of fashioning the fragments thus obtained into instruments of war and agriculture we can not hope ever to definitely ascertain, but of this we may be absolutely certain, that the intellectual labors and expenditure of patience required to elaborate these crude beginnings of metallurgical science must have far exceeded the labor which, with all the wealth of accumulated experience and organized scientific knowledge we now possess, suffices to accomplish the elaboration of the numerous refinements and improvements of the metallurgical arts which are constantly issuing from our laboratories to-day.

During the ages which witnessed these remarkable developments of human control over nature, parallel developments had inevitably occurred in the juridical and political institutions of mankind. It may however be safely inferred that these developments rarely preceded but were rather the consequence of the development of man's control over his environment. From their very nature it follows that these institutions are opportunist, and deal with things and men as they find them. For a politician in a pastoral society to frame and enact legislation adapted to an industrial population would be a folly which would speedily and inevitably precipitate disaster. Laws, whether laws of custom, tribal etiquette, or statutory enactment, were necessarily adapted to the people and environment on which they were imposed. Nothing can be clearer then, than that the formative forces which have created civilization have not resided in these institutions of mankind which have merely crystallized preexisting conditions into avowed and recognized forms. The creative forces have resided elsewhere and

their source, whether expressed as the material outcome of science or the spiritual outcome of religion, must be sought in the creative curiosity of man operating through the medium of a discipline of thought which has in every age been essentially identical with the now avowed and self-conscious discipline of thought which is most extensively and successfully employed by the scientific men whom we term to-day investigators and inventors. The ascent of man has therefore not been due, as historians would have us believe, to superhumanly wise statesmen, conquerors or administrators but solely to science and to the anticipations of its fruition which formed the basis of religions.

The increasing complexity of needs and industries now compelled co-operation, the improvement in the machinery of war, backed by the organization and discipline which sprang up in answer to the opportunities this machinery afforded, rendered extensive conquests feasible and the developments of agriculture rendered possible enormous accumulations of population in especially favorable localities. Hence at the dawn of recorded history we find the great river-beds and deltas of the east inhabited by dense populations loosely welded by conquest into inchoate empires.

The close association and interdependence of interests and information which these aggregations of humanity compelled furnished a tremendous stimulus to the development of knowledge and the control of the environment which they inhabited. Vanity inspired monumental architectural undertakings, necessity created intensive agriculture and vast irrigation enterprises, commercial or military necessity created ships out of the canoes and cockle-shells of primitive fishermen, and through the interchange of information and imitation and reapplication of successful devices a comprehensive rearrangement of preexisting knowledge took place, analogous to the modern development of the card index or vertical file from the bound register of inflexible dimensions, a rearrangement which without of necessity adding anything to knowledge, rendered existing knowledge very much more efficient.

During the growth of these great empires a people had arisen in the west, who were but little favored by natural environment but among whom the instinct of curiosity attained the intensity of a passion. Their very intelligence and energy, however, forbade their conquest and fusion into large conglomerates, while the absence of natural conditions favorable to the formation of dense aggregates of population subjected them to a wide dispersal and constant conflict with the forces of nature and with each other. Only the example afforded by contact with more favored and therefore more advanced civilizations was required however to bring about a speedy reversal of the relations of master and pupil in the curricula of civilization. The Greeks, whose gift of inspired curi-

osity has never been surpassed, perhaps indeed never equalled, most happily, by geographical proximity, furnished the connecting channel by which the accumulated knowledge of the east flowed to the receptive peoples of the west. But with their restless temperament and intellectual gifts the Greeks could not be mere passive recipients of facts. Everything that they received from Egypt, from Persia and from Asia Minor was transmitted to the west and to posterity marked with the indelible stamp of Greek genius. Isolated facts garnered from the east were multiplied by Greek investigators and welded into comprehensive generalizations.

For the first time the professional scientist who pursued science for its own sake appears in history. The multitude of isolated medical observations of the ancients were multiplied and interwoven into a system of medical practise by Hippocrates of Cos, and so intense was the enthusiasm and idealism with which he inspired his students that to this day the medical student enters upon the practise of his profession with the avowal upon his lips of the principles of medical practise which were enunciated by this great master. Geometry was applied to science by Archimedes and the fruits were the foundations of hydrostatics and mechanics. Great systematists like Democritus and Aristotle gathered together countless facts of nature and endeavored to weld them into a connected and interpretable whole.

With pupils such as these it is not surprising that the antique wisdom of the east had soon to turn to the west for inspiration. Greek architects were in request from the Ganges to the White Nile and Greek engineers directed the construction of those massive feats of engineering which were the stable foundations of the Roman Empire.

The fall of the Roman Empire, at first seeming the absolute destruction of civilization, simply resulted by steps which are too well known to require description here, in the dispersal of the seeds of knowledge over the continent of Europe. The practical knowledge of the Greeks was safe in the hands of countless artisans and engineers who transmitted it by word and example, enriched by experience and practise, to generations which succeeded them. The more abstract generalizations and inspired literature of the Greeks were kept alive by the sudden awakening into intellectual activity of a people who never before had evinced, and, their task accomplished, have never since displayed capability or desire of assimilating and constructing thought. Not only did the Arabs preserve for us the most perfect fruits of Greek thought, but they contrived a fresh and most significant importation from the east, algebra, the distinctive product of the contemplative rather than the kinetic intellect, a system of thought as truly expressive of the mentality of the peoples of India to whom we owe it as geometry was of the more rugged and virile mentality of the Greek.

Through the Feudal Ages, progressing slowly but inevitably towards the dawn of the renaissance, the seeds sown broadcast by the fallen empire germinated and brought forth fruit. By imperceptible degrees man's mastery over his environment became more complete, the slow sure grasp of science, never again to be relaxed, compelled nature to yield her secrets one by one. The augmenting industrialism and feats of engineering which heralded the renaissance were the fruit of the unregarded effort of countless individuals each of whom added a particle of knowledge to the accumulated store of science.

Practical knowledge was far advanced, but had fallen again into the disconnected condition in which the Greeks at an earlier period had received it from the east. Algebra was an independent branch of human thought, bearing no obvious relation to anything of practical import. The scientific discipline of thought, unconsciously employed by every artisan and engineer, had never been consciously formulated or avowed. The material was there, it awaited only the coming of the man who should weld it together and vitalize it with the inspiration of genius.

The man was found in René Descartes, who, as he tells us,³ in the seclusion of "a room heated by a stove" wedded algebra to geometry, mathematics to science, and at the same time formulated in words and translated into acts one of the fundamental canons of scientific method, namely "*a plurality of suffrages is no guarantee of truth.*"

On that day science attained its majority and assumed self-consciously the burden of its appointed task. The last link was forged in the long chain of human endeavor which stretches from the insatiable aimless curiosity of our well-nigh Simian ancestors to the sublime conceptions of a Newton.

Of all strong things none is more wonderfully strong than man. He can cross the wintry sea, and year by year compels with his plough the unwearied strength of earth, the oldest of the immortal gods. He seizes for his prey the airy birds and teeming fishes, and with his wit has tamed the mountain-ranging beasts, the long-maned horses and the tireless bull. Language is his, and wind-swift thought and city-founding mind; and he has learnt to shelter him from cold and piercing rain; and has devices to meet every ill, but death alone. Even for desperate sickness he has a cure, and with his boundless skill he moves on, sometimes to evil, but then again to good.⁴

⁴ Sophocles, "Antigone."

³ "Discourse on Method," part II.

THE CONSERVATION OF THE NATIVE FAUNA

BY WALTER P. TAYLOR

MUSEUM OF VERTEBRATE ZOOLOGY, UNIVERSITY OF CALIFORNIA

THE ascendancy of man has been accompanied by certain inevitable changes and readjustments in nature. Probably the most conspicuous of these changes is that brought about by the cutting down of forests. Almost as conspicuous, and perhaps even more worldwide in distribution, are those changes resultant upon the destruction of the native fauna, and particularly of birds and mammals. In practically every country of every continent where formerly the "wild flocks and herds held sway," man has crowded out or thoughtlessly destroyed the resident animals until the problem of the preservation of representative faunas is coming to be one of the important concerns both of zoologists and governments in widely separated localities. With this as the background, it now becomes peculiarly desirable to trace the recent history of some of the more important species, limiting ourselves perforce to a few members of one of the great classes in a geographic area of limited extent.

Perhaps there is no more favorable unit in which to carry on our study than that comprised within the boundaries of California. Characterized not only by comparatively great area, but also by climatic features ranging from almost subtropical to boreal, and by a topography of almost infinite variety, it is small wonder that California possesses a mammal list including 369 different species or subspecies, as compared with 80 for Kansas,¹ 94 for Nebraska,² 152 for Colorado,³ and 182 for Texas.⁴

Obviously the species likely to be in greatest danger everywhere are the game species, plus those species against which a public prejudice exists for one reason or another, and those species which, through the fur trade or otherwise, enter into the world's commerce.

Although it must be admitted that much of her inheritance has passed away, there is still plentiful evidence to indicate that California possessed an early fauna of such generous abundance as to justify according her a place among the big game countries of the world.

What are the specific items? Of the smaller fur-bearing species

¹ Swenk, "Nebraska Blue Book," 1915, p. 836.

² The same, pp. 851-855.

³ Cary, U. S. Dept. Agric., Bureau Biol. Surv., N. Amer. Fauna, 33, 1911, pp. 51-211.

⁴ Bailey, U. S. Dept. Agric., Biol. Surv., N. Amer. Fauna, 25, 1905, pp. 51-216.

there are forty-seven, distributed according to current taxonomic conceptions, as follows: three coyotes, seven gray foxes, four red foxes, one ringtailed cat, four species of raccoon, one marten, one fisher, one wolverine, four weasels, one mink, five spotted and the same number of striped skunks, two badgers, one river otter, the sea otter, four wild cats, and two beavers. This does not take account of any domestic species, nor of the native aplodontias, marmots, squirrels, musk-rats or rabbits, the fur of which doubtless occasionally found place in the early industries of the state.

Beside the smaller species just enumerated, our fauna contained a sea elephant, and is or was characterized by a goodly list of species of more strictly big game mammals, including the pronghorned antelope, two species of bighorned sheep, the same number of black bear, two species of elk, two of mountain lions, five of deer, and six of grizzly bears.

By outlining the status of the more important of these mammals, and by following them in some of the vicissitudes of their contact with man, we can perhaps best gain a conception of what we did have, what we still have, and what the general trend of events promises for the future.

FUR-BEARING MAMMALS

Concerning the less important fur-bearers there are few comparative data. Evidence gathered over several years from numerous trappers indicates their steady decrease. Even yet the economic value of these for the most part unappreciated members of our fauna is not inconsiderable. In fact, according to one estimate,⁵ California's fur-bearing mammals, including only the bears, raccoons, skunks, badgers, river otter, mink, marten, fisher, red foxes and wolverine, at the present time produce an income which makes them worth seven million dollars to the state.

Of the fur-bearing land mammals, the otter and beaver seem to have been the most important. The abandonment of California as a field of work by the Hudson's Bay Company in 1841 is in itself unmistakable testimony regarding the decrease in numbers of these species. So far as can be ascertained at the present time, the otter is represented by comparatively few individuals on the "streams of northern California, south at least to Mendocino County, and through the Sacramento and San Joaquin valleys to the San Joaquin River, Fresno County."⁶

THE BEAVER

In 1829 McKay, working in the interest of the Hudson's Bay Company, is said to have trapped 4,000 beavers along the reedy shores of

⁵ Taylor, *Science*, N. S., March 28, 1913, pp. 485-487.

⁶ Grinnell, *Cal. Acad. Sci.*, 4th Ser., 3, 1913, p. 297, and Univ. Calif. Publ. Zool., 12, 1914, pp. 305-310.

San Francisco Bay alone. Dr. T. S. Palmer, in a conversation with the writer, asserted that in the seventies the lowlands of the San Joaquin Valley were a veritable trapper's paradise. In the ark of one trapper, on Old River, about fifteen miles above Webb's Landing, in the spring of 1877, he saw beaver skins piled flat as high as a six foot door. Evidently the beaver has become scarcer and still more scarce as the years have gone by, until it has seemed doubtful whether the species could survive even with the total protection which has for several years been accorded it. It must be admitted that of late the outlook is more hopeful. There is said to be a colony of one hundred and fifty in the Cache Slough district in the Sacramento River, as well as another considerable colony on the San Joaquin River near Mendota; and scattered individuals and colonies have been reported from the Pit, Sacramento, Merced, Tuolumne and Stanislaus rivers. It is probable that a few still occur on the Feather and American rivers, but the exact status of the species on these streams at present is unknown.

THE SEA ELEPHANT

We are prone to forget or overlook the intimate relation between the interests of man and the presence of the native animals. An illustration of what is perhaps one of the more unusual of these relationships is furnished by the case of the sea elephant, the abundant oil of which, according to Stephens, was much in demand as an illuminant in the early days in this state previous to the general use of coal oil. The market created by pioneer necessities, coupled with the sluggish temper of the animal, both mental and physical, evidently conspired to work its doom in our waters. Formerly found in some numbers, we must believe, along our southern coast and as far north as Point Reyes, it is gone completely from our shores, being reduced to a handful of survivors on Guadalupe Island off the coast of Lower California.⁷

THE SEA OTTER

The most aberrant of all living fissipedian carnivores as well as "the most valuable fur-bearing mammal in the world" is the sea otter. These animals were present in abundance off our shores at least until the early part of the nineteenth century. Bryant⁸ has called attention to the fact that in the year 1801 no less than sixteen ships, one English and fifteen American, were on the Californian coast engaged in the pursuit of the sea otter. Bancroft, the historian, asserts that 18,000 otter skins were collected that year for the China market by the American vessels alone. In 1812 as many as seven or eight hundred sea otters

⁷ See Townsend, *Proc. U. S. Nat. Mus.*, 8, 1885, pp. 90-93; "Pelagic Sealing, Extract from the Fur Seals and Fur Seal Islands of the North Pacific Ocean," Part III, 1899, p. 267; and *Zoologica*, 1, 1912, pp. 172-173.

⁸ *Calif. Fish and Game*, 1, 1915, p. 97.

are said to have been killed in San Francisco Bay. These statements may be exaggerated, but they do indicate that the sea otter was an important object of pursuit. In 1785 the price ranged from \$1 to \$7 per skin.⁹ In 1880 the average skin taken off our coast brought \$80, while in 1910 the average price paid for sea otter skins in London was said to be \$1,703.33. These figures seem to indicate that the demand is inversely proportional to the number of the animals available. For it should be remarked that although the sea otters formerly occurred in suitable localities all the way along our coast, they have completely disappeared from off northern and southern California, although individuals and small companies are still observed in the vicinity of Point Sur, Monterey County, and there is some evidence to indicate that since the passage in 1913 of the law giving them rigorous protection they are increasing slightly.

DEER

The deer is at the present time the most important game mammal in the state, and promises to maintain its preeminence for many years to come. Few species have been able to adapt themselves to the occupation of man as well. But this does not mean that there has not been a decrease in numbers. Hittell,¹⁰ writing of the black-tailed deer, says:

In 1835, when Dana sailed into the bay of San Francisco, the hills around and the islands in the bay were overrun with them. On a sloping bluff near the Golden Gate, under which his vessel anchored, there were herds of hundreds upon hundreds, which stood still and looked at the ship, until, frightened by the noises made for the purpose of seeing their graceful movements, they bounded off.

Traffic in deer hides was carried forward until a comparatively late date. In 1842 deer and elk hides brought only from fifty cents to a dollar apiece in San Francisco. The considerable traffic which was carried on even at these low prices bears unmistakable testimony to the great numbers of the species concerned. Evidently deer were numerous, not only in the mountains, but on the plains, where now the sight of one would awaken the most extraordinary interest.¹¹

Nominally there are five subspecies of deer within the state, two of black-tailed, three of mule deer.

The Columbia black-tail is still found abundantly in the northern coast district south to the Golden Gate, its range embracing Mount Shasta to the north and east, and taking in all the coast ranges east to the Sacramento Valley.

In the coast belt south of San Francisco, at least to Monterey and San Benito counties, its place is taken by the southern black-tail.

⁹ Bryant, *Calif. Fish and Game*, 1, 1915, p. 97. Probably none of the skins sold in London in 1910 came from Californian waters.

¹⁰ "History of California," 2, 1898, p. 562.

¹¹ Newberry, *Pac. R. R. Reports*, 6, 1857, Zoology, p. 66; and Bosqui, "Memoirs," 1904, p. 62, 66.

The true mule deer is the form characteristic of the Sierra Nevada and the mountains of the extreme northeastern portion of the state in Modoc county. The mountains in southern California west of the desert proper are occupied by a small subspecies called the California mule deer, the range of which extends north at least to San Luis Obispo county and the Tehachapi mountains.

The burro deer (*Odocoileus hemionus eremicus*) formerly occurred on the deserts of the southwestern portion of the state bordering on the Colorado river. Members of the expedition from the Museum of Vertebrate Zoology to this region in 1910 were unable to find so much as a trace of the presence of the species, although they were told of its occurrence in numbers many years before, "... when they were to be found both in the river bottom and back through certain desert ranges, where there are springs which the deer could visit regularly for water."¹² No one in the vicinity had seen a deer within four years. As the record runs the date of the extirpation of the burro deer in California may be set down as approximately 1905 or 1906.

I may not leave the account of the deer without remarking the persistent rumors of the occurrence in the Modoc region of extreme northeastern California of white-tailed deer (*Odocoileus virginianus macrourus*); but so far no definite evidence in the shape of specimens has come to light.

It is quite certain that not only have the deer decreased markedly since the beginning of the nineteenth century but also that they are fewer in numbers than they were, say, ten, or twenty years ago. In some sections, notably in southern California, they are losing ground rapidly; in others, as in the Trinity-Siskiyou region of northern California, they are reported to be holding their own and even in certain localities to be increasing. It is not improbable that the number of deer killed by hunters under modern conditions, large as it is, aggregates a much smaller total than in former days, when individual bands of hide and market hunters slaughtered deer by hundreds and even thousands in a season.

Incidentally, testimony to the size of California and to her comparative supremacy as a game state even yet is given by the fact that in few states are more deer killed annually than are killed within her borders.

ELK

Our largest ungulate is the elk or wapiti, of which we have two species; one, perhaps known most commonly as the Roosevelt elk (*Cervus roosevelti*) formerly found numerously in the humid north coast belt south at least to the Golden Gate and east to Mount Shasta; the other, the valley elk (*Cervus nannodes*) found predominantly in the San Joa

¹² Grinnell, Univ. Calif. Publ. Zool., 12, 1914, p. 219.

quin Valley and low-lying regions tributary thereto. Dr. Newberry,¹³ writing of the elk in early days, says:

West of the Rocky mountains, it was formerly most abundant in the valleys of California, where it is still far from rare. In the rich pasture lands of the San Joaquin and Sacramento, the old residents tell us, it formerly was to be seen in immense droves, and with the antelope, the black-tailed deer, the wild cattle, and mustangs, covered those plains with herds rivalling those of the bison east of the mountains, or of the antelope in south Africa.

Bosqui¹⁴ while making a journey from Stockton to Mariposa in December, 1850, records seeing "bands of elk, deer, and antelope in such numbers that they actually darkened the plains for miles, and looked in the distance like great herds of cattle."

Hittell¹⁵ includes as one item in a list of exports from San Francisco in 1842 three thousand elk and deer skins at prices ranging from fifty cents to a dollar. Robinson¹⁶ asserts that the American elk, occurring on the northern side of San Francisco Bay, was then hunted for its tallow, which was preferred to that taken from bullocks.

At the present time the Roosevelt elk is making a last stand in the extreme northwestern portion of the state in the counties of Humboldt and Del Norte; while the valley elk is reduced to a herd in the tule lands of the southern San Joaquin Valley estimated to contain four or five hundred head. In 1905 the United States Department of Agriculture succeeded in transporting twenty-six of these elk to the Sequoia National Park in Tulare County, where the herd has now increased to about fifty head. About a year ago the California Academy of Sciences distributed fifty-four of the valley elk to seven parks and reservations in different parts of the state, where conditions were most favorable for their survival.

That the elk has taken a strong hold upon the interest and imagination of the people of California is shown by the fact that the killing of an elk within the state is made a felony, which is the severest penalty imposed for the violation of any game law within the commonwealth.

MOUNTAIN SHEEP

The description of the mountain sheep of the high Sierra by Grinnell¹⁷ is one of the most interesting of recent developments in California mammalogy. The pioneer zoological investigators¹⁸ connected with the Pacific railroad surveying parties all report mountain sheep on Mt. Shasta. Newberry's account says:

¹³ Pac. R. R. Reports, 6, 1857, Zoology, p. 66.

¹⁴ Quoted by Evermann, *Calif. Fish and Game*, 1, 1915, p. 86.

¹⁵ "History of California," 1898, 2, p. 479.

¹⁶ "Life in California," 1846, p. 61.

¹⁷ Univ. Calif. Publ. Zool., 10, 1912, pp. 143-153.

¹⁸ Newberry, Pac. R. R. Reports, 6, 1857, Zoology, p. 72; Kennerly, same, 10, 1859, p. 72; and Suckley and Gibbes, same, 12, p. 137.

On the slopes and shoulders of Mount Shasta the *Ovis montana* exists in large numbers; so much so that one spur of the mountain has been named "Sheep Rock" and there hunters are always sure of finding them.

The bighorn was referred to also as being habitually present in the vicinity of Rhett and Wright Lakes, eastward from Mount Shasta. The Modoc Expedition from the Museum of Vertebrate Zoology, 1910, found evidence of their former presence in the Warner Mountains of extreme northeastern California. Stephens¹⁹ asserts that bighorns were "... formerly found in parts of the Sierra Nevada and on Mount Shasta, but they are apparently now exterminated in those mountains."

In October, 1911, in a section of the Sierra Nevada which is a portion of one of the wildest and most scenic regions in the world, there were secured the specimens on which the description of the form was based. It is asserted by Ober,²⁰ deputy fish and game commissioner for the district, that there are three bands of the Sierran bighorn ranging over a comparatively restricted tract of jagged and precipitous country on the face of the Sierran fault block. Grinnell²¹ has set the northern and southern limits of range of the species as being respectively Mono County and Mount Whitney. A recent definite record of bighorns on the west slope of the Sierras is for the north spur of Mount Silliman, altitude 10,600 feet, within the Sequoia National Park, where sheep were seen August 19, 1910.²² It is quite likely that the former range of the species included Mount Shasta and the Modoc region.

The Nelson bighorn, a smaller, shorter-haired species than its Sierran relative, is typical of the desert ranges of southeastern California, from the Inyo region south at least to the Mexican line.²³ Formerly it is said to have occurred northwest through the Tejon region to the Caliente Hills, San Luis Obispo County, and there are reports of its persistence still in scattered localities in this general district. At present the desert sheep is apparently increasing in some sections of its range, notably the desert ranges in Inyo County,²⁴ and stationary or decreasing in others, as in the desert portions of the more southerly counties, San Bernardino, Riverside and Imperial.²⁵ There are, fortunately, some large bands which promise well, and which at least indicate that there is no cause for concern over the immediate future of the species within the state.

¹⁹ "California Mammals," 1906, p. 58.

²⁰ 23d Bien. Rpt., Calif. Fish and Game Com., 1914, p. 125.

²¹ *Proc. Calif. Acad. Sci.*, 4th Ser., 3, 1913, p. 369.

²² [Fry], "Sequoia and Gen. Grant Nat. Parks," *Gen. Inf., Dept. Int.*, 1915, p. 22.

²³ Grinnell, *Proc. Calif. Acad. Sci.*, 4th Ser., 3, 1913, p. 369.

²⁴ Ober, 23d Bien. Rpt., Calif. Fish and Game Com., 1914, pp. 123-124.

²⁵ See Stephens, same, pp. 128-130.

PRONGHORNED ANTELOPE

Of the pronghorn (*Antilocapra americana*) referred to by Chalmers Mitchell²⁶ as one of the most isolated and interesting of living creatures, formerly represented by herds of thousands of individuals found practically everywhere on Californian plains, we have only scattering bands remaining. There are still a few in the Modoc region of north-eastern California, on the arid western side of the San Joaquin Valley, in that part of the Mohave Desert known as Antelope Valley, and possibly in scattered localities in the extreme southern part of the state. This is the animal which was only a few years ago one of the most conspicuous features of the Californian plains and deserts, as witness the following from Newberry:

Though found in nearly all parts of the territory of the United States west of the Mississippi, it is probably most numerous in the valley of the San Joaquin, California. There it is found in herds literally of thousands; and though much reduced in numbers by the war which is incessantly and remorselessly waged upon it, it is still so common that its flesh is cheaper and more abundant in the markets of the Californian cities than that of any other animal.²⁷

It is not improbable that the antelope's former habitat extended nearly or quite to tidewater. Dr. Colbert A. Canfield of Monterey, who seems to have been a close and careful observer, wrote to Professor Baird in 1858 as follows:

In your report you say nothing of the existence of the antelope on this side of the Sierra Nevada; but I can assure you that they abound everywhere in all the plains and valleys of the western slope, down to the Pacific Ocean.²⁸

A. Robinson in his "Life in California"²⁹ writes of the San Francisco bay region:

On the northern side of the bay are found the American elk and antelope, and great quantities of deer. . . .

J. Ross Browne, writing in 1864, says with reference to country traversed by him:

A large portion of the country bordering on the Salinas river, as far south as the Mission of Soledad, has been cut up into small ranches and farms; and thriving settlements and extensive fields of grain are now to be seen where formerly ranged wild bands of cattle, mustang, and innumerable herds of antelope."³⁰

The pronghorn was apparently sustaining about all the competition it could withstand before the advent of the white man. Since his coming it has been on the downgrade. Apparently his best efforts will be necessary to preserve its life.

²⁶ *Science*, N. S., Sept. 20, 1912, p. 357.

²⁷ *Pac. R. R. Reports*, 6, 1857, Zoology, p. 71.

²⁸ *Proc. Zool. Soc. London*, 1866, p. 110.

²⁹ *New York, Wiley and Putnam*, 1846, p. 61.

³⁰ "Crusoe's Island," *New York, Harper's*, p. 174.

THE BLACK BEAR

Our biggest living carnivore is the black bear. One subspecies is found in the Transition and Boreal zones of the coast mountains north of San Francisco Bay, while the other, the exact status of which remains to be elucidated, occupies the Sierra Nevada south to the vicinity of the Tehachapi Mountains.²¹ Apparently the black bear has never been found either in the coast district south of San Francisco or in southern California.

Although constant persecution has resulted in considerable reduction in its numbers, the black bear has proved a much more resilient and adaptable species than the grizzly; and there are good grounds for the hope that with fair treatment it may be counted on as an important big game and fur-producing species for many years to come.

THE GRIZZLY BEAR

Beyond all question the group of her grizzly bears was the most vividly impressive portion of the native fauna of California. No less than six distinct forms are now recognized by Dr. C. Hart Merriam²² as belonging to the fauna of California alone.

Let me briefly list them: *Ursus klamathensis* is described from Klamath river; *Ursus colusus* is from the Sacramento Valley, the type skull coming, in all probability, from somewhere on the river between Colusa and Sacramento; the huge *Ursus californicus*, known by name longer than any of the others, is restricted to the Monterey region; from the historic old Fort Tejon, in the Tehachapi Mountains, comes *Ursus californicus tularensis*, also found in certain ranges of southern California; the smallest of them all, *Ursus henshawi*, comes from the southern Sierra Nevada; while the Trabuco Mountain region of southern California was the home of the gigantic *Ursus magister*, the "... largest of known grizzlies, considerably larger than *Ursus californicus* of the Monterey region, and even than *Ursus horribilis*, the great buffalo-killing grizzly of the plains (only equalled by the largest *alexandrae* of Kenai peninsula)."²³

Bryant²⁴ records the fact that Bidwell, in Rogers's "History of Colusa County," states that when the county was first settled it was not uncommon to see thirty or forty grizzly bears in one day.

Hittell submits the following:

In early times grizzly bears were very plentiful all over the country and did great damage to the cattle and gardens of the first settlers. In 1799 the troops of Purisima made a regular campaign against the bears of that region.

²¹ Grinnell, *Proc. Cal. Acad. Sci.*, 4th Ser., 3, 1913, p. 284; and C. H. Merriam, conversation.

²² *Proc. Biol. Soc. Wash.*, 27, 1914, pp. 173-196.

²³ Merriam, *Proc. Biol. Soc. Wash.*, 27, 1914, p. 189.

²⁴ *Calif. Fish and Game*, 1, 1915, p. 96.

In July, 1801, Raymundo Carrillo wrote from Monterey that the vaqueros in that neighborhood had within the year killed thirty-eight bears, but that the depredations by others continued unabated; and he proposed an ambuscade by the troops at a certain place where the carcasses of a few old mares should be exposed.³⁵

Newberry writing in 1857 asserts concerning the grizzlies:

They are rather unpleasantly abundant in many parts of the Coast Range, and Sierra Nevada, in California, where large numbers are annually killed by the hunters, and where not a few of the hunters are annually killed by the bears.³⁶

The general vividness with which the grizzly impressed himself upon the pioneers as the original native son is indicated by the fact that he was painted, by common consent, as the totem of the commonwealth, on the first flag of the "California Republic."

For several years strenuous efforts have been made to obtain authentic records of living grizzlies in California, so far without success. It seems quite safe to state that each and every one of the six species is now completely extirpated from our fauna.

For the outline of the former range of these bears we must look forward to the publication of the results of Dr. Merriam's exhaustive researches. The fragmentary material now available will not permit of any detailed distributional statements. The actual dates of extermination of the various species are uncertain. The skull from the southern Sierra Nevada, which became the type of *Ursus henshawi*, was collected by Dr. J. T. Rothrock and H. W. Henshaw in 1875. Two specimens, skins only, from the Tehachapi region, and supposedly referable to *Ursus californicus tularensis*, are in the Museum of Vertebrate Zoology and were collected in the Tejon (or San Emigdio) Mountains, between San Emigdio Ranch and Old Fort Tejon, between 1893 and 1896. The type of the huge *Ursus magister* of southern California was shot in the Santa Ana Mountains in August, 1900 or 1901, and there are no known records subsequent to this date.

THE ZOOLOGIST AND THE PRESERVATION OF THE NATIVE FAUNA

That California's early endowment of wild life was generous indeed seems clearly to be indicated by this brief survey; and that there has been a steady decrease in numbers of practically all the game and fur-bearing mammals seems to be equally clear. We now count, among mammals alone, at least eight species which are totally extirpated from our fauna.

Nor is California a special offender. The same story of the dwindling numbers of the native animals is repeated in nearly every state of the Union; and similar stories are told in Europe, Asia, Africa, South America and Australia.

³⁵ "History of California," 2, 1898, pp. 560-561.

³⁶ Pac. R. R. Reports, 6, Zoology, p. 47.

There are few people in these days who deny that when the mountains are spoiled of their forests; when conspicuous and interesting species of game or bird life are destroyed; when any of the natural resources of the people are wasted, then progress is impeded, constructive works retarded, and the conditions of existence rendered more severe.

Fundamental to conservation is scientific research, of course; admittedly our investigations have not penetrated very deeply into the unknown, and this first phase of our work is prerequisite to every other phase. It will doubtless be admitted, however, that we can not possibly postpone action until all points in all problems become clear. This being the case it is due the commonwealth that all available information be brought to bear when legislative action is contemplated; and it is evident that the only citizens who possess any considerable body of information pertinent to the biological side of the problem of conservation are the professional biologists.

It is, fortunately for all concerned, coming to be realized in ever-increasing degree, that in a democracy, the zoological representative of the people, if I may so speak, should maintain cordial and sympathetic relations with those from whom his support is derived and whom he is endeavoring to serve, and that it is only fair that he freely and generously assume a place of leadership in the campaign for the preservation of the native fauna. Indeed, is it not true that unless the zoologist does take pains to get the word to the people at critical times, upon him must inevitably fall a share of the blame for ignorant and destructive popular action, legislative and otherwise?

THE PROGRESS OF SCIENCE

THE CONTROL OF EPIDEMIC DISEASES AND THE CAUSES OF DEATH

THE only redeeming feature of the terrible epidemic of infantile paralysis which began in Brooklyn and has spread as far as Philadelphia and Boston, is the attention which it has directed to the control of communicable disease. It may be that the attitude of the public and of certain health boards has been somewhat hysterical, but as a matter of fact it has only been so in certain directions. Thus less than three per cent. of the cases occur in those over ten years of age, and except in so far as they may be carriers of the disease the risk is so small as scarcely to warrant any quarantine or the closing of a university such as Princeton. It is, however, almost impossible to overestimate the importance of using even drastic measures to suppress epidemics. What has been accomplished with cholera, the plague and small-pox can be done in the case of other diseases.

There are here reproduced several diagrams from the United States Census Reports and the Report of the English Registrar General which show the relative death-rates of different countries and the death-rates from different diseases. It is an extraordinary fact that three times as many people should die in Chile as in New Zealand, twice as many in Hungary as in Sweden. These differences also represent the progress made by the more advanced nations. The death-rate in England, for example, has in the course of fifty years been reduced from 22 to 13 per thousand. People live about twice as long as they did a century ago and about four times as long as they did in the middle ages.

The curves for the principal causes of death in the United States show great changes even in the course of a period

so short as twelve years. The most satisfactory aspect of these curves is the decrease in tuberculosis, typhoid and diphtheria, due in the main to three different methods of control, the first to more hygienic conditions of living, the second to suppression of the sources of the epidemic, the last, in part at least, to the antitoxin treatment. There are greater variations in pneumonia and infantile diarrhea, they being influenced by seasonal variations, but on the whole a satisfactory decrease is indicated.

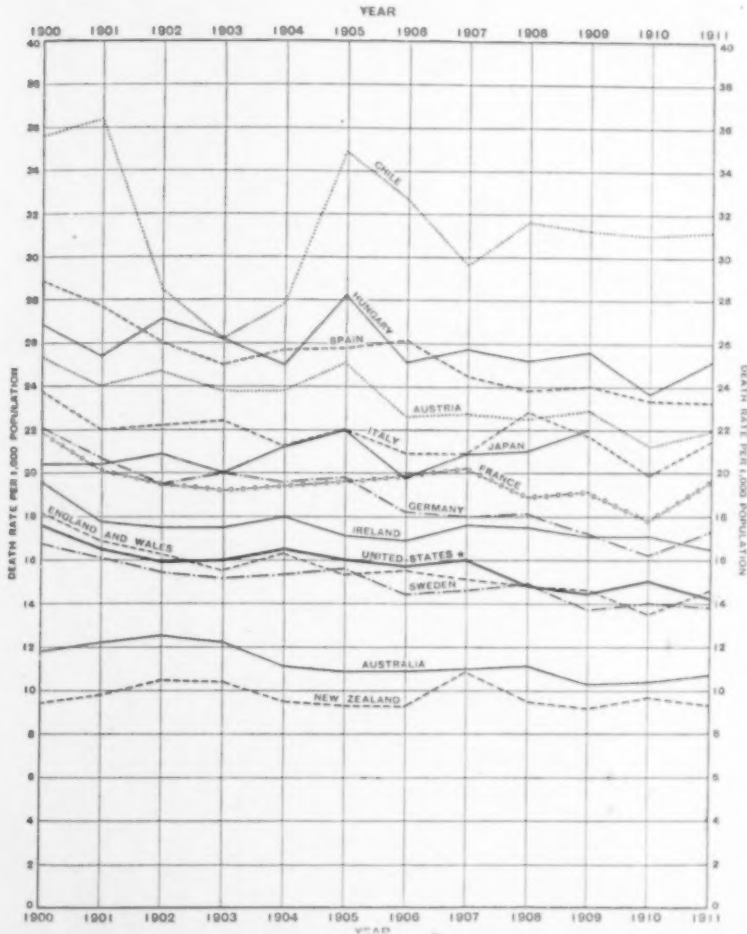
The most unsatisfactory curves are those for the three children's diseases—measles, scarlet fever and whooping cough. They are curiously equal in their incidence and have remained almost constant in their fatality for twelve years. They are far more dangerous than infantile paralysis has hitherto been; they should be regarded with the same dread and their suppression should be undertaken with the same vigor. This is especially indicated by the English figures, where the deaths from these diseases, especially scarlet fever, have greatly decreased. Fifty years ago the annual death-rate from scarlet fever was over 2,600 per million children and this has now been reduced to 250. It is a curious fact that diphtheria since the use of the antitoxin treatment has decreased at only about the same rate as the other diseases, and that it is now as large a cause of death as fifty years ago, while deaths from scarlet fever have been reduced to one tenth.

The increase of the organic diseases of later life is marked. Thus the most striking feature in the American statistics is the crossing of the curves for the two most fatal diseases, tuberculosis and heart disease. In 1900 the death rate from the former was 202 per hun-

dred thousand, from the latter 122, but in 1912 the rate for heart disease had become higher than for tuberculosis. An increase is also evident in Bright's disease, apoplexy and cancer. The in-

epidemics and the diseases of infancy and youth death must sooner or later occur through some organic failure.

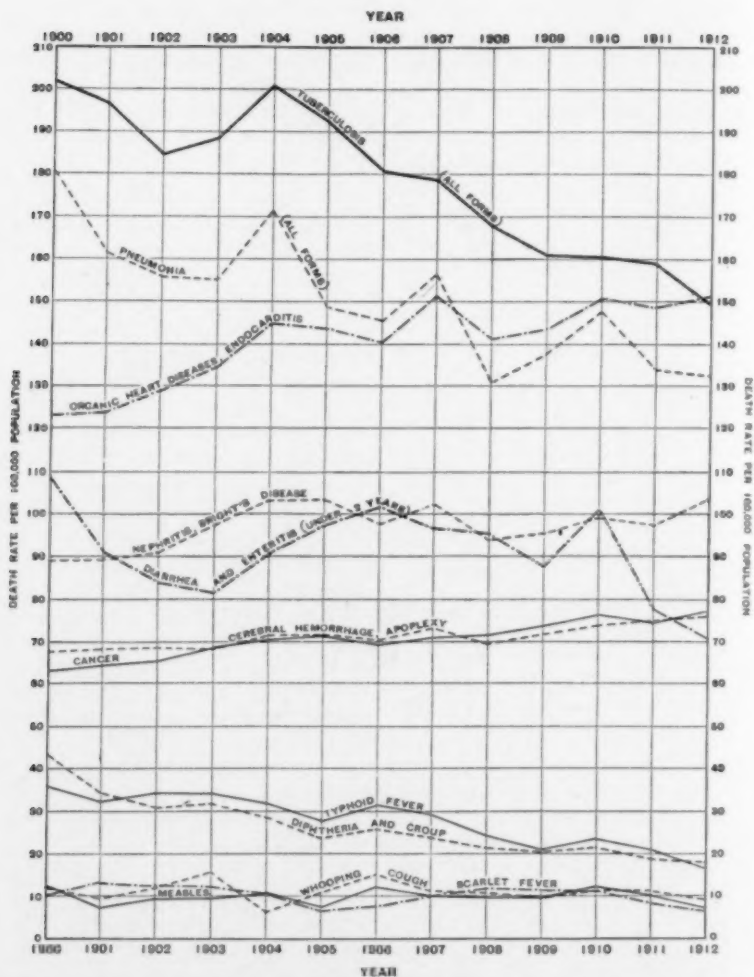
The fact that the death rate between forty and sixty has remained about sta-



GENERAL DEATH RATES OF THE UNITED STATES (REGISTRATION AREA) AND CERTAIN FOREIGN COUNTRIES: 1900-1911.

crease of these diseases has attracted public attention, and has been adduced as evidence of the disastrous pressure of the conditions of modern life in cities and the like. As a matter of fact, an increase in the deaths caused by these diseases may be regarded as propitious. People must die, and if we suppress

tionary in recent decades, while the rate for earlier ages has so greatly decreased, is another matter. This has been interpreted to mean that improvements in hygiene and medicine have been offset by bad conditions of living, the use of alcohol and other drugs, the overpressure of business, the pursuit



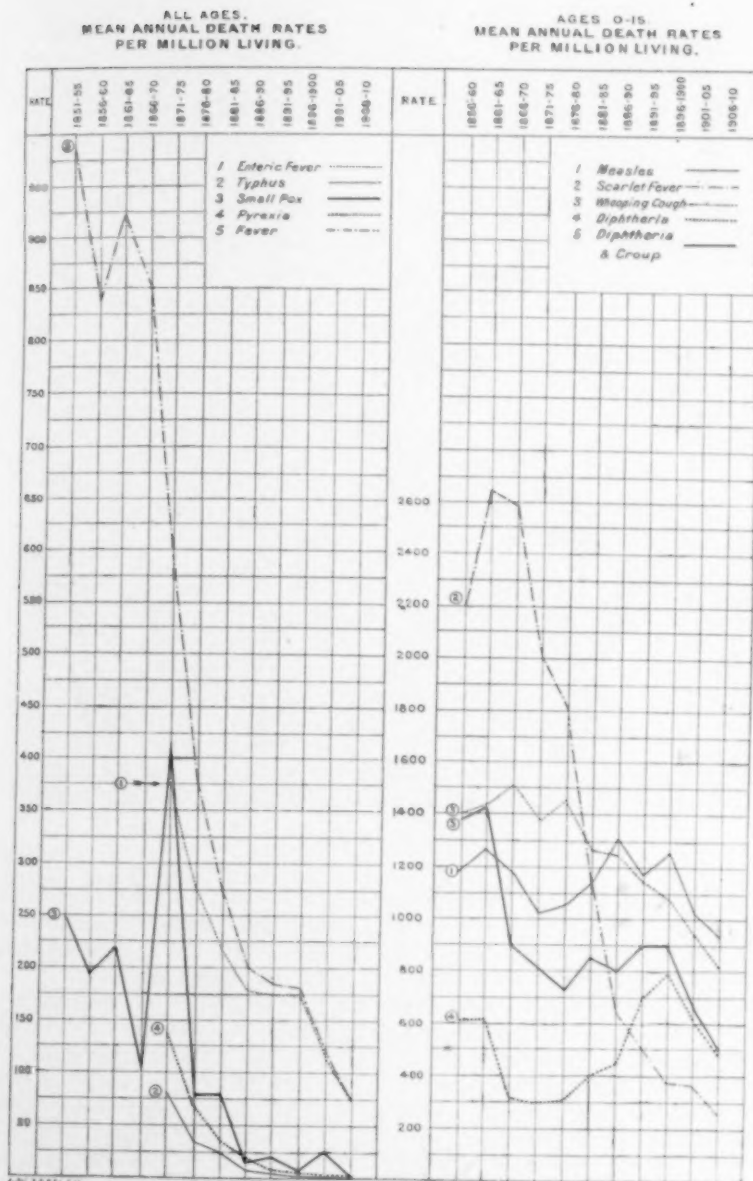
DEATH RATES FROM IMPORTANT CAUSES OF DEATH IN THE REGISTRATION AREA OF THE UNITED STATES: 1900-1912.

of pleasure and the like. But another explanation may be urged. If we preserve the lives of hundreds of thousands of infants who can not be properly nursed by their mothers and of hundreds of thousands of young people of inferior constitution who would previously have succumbed to tuberculosis, we have in the population between forty and sixty a large proportion of people less vigorous than those who would have survived harsher conditions. It is not

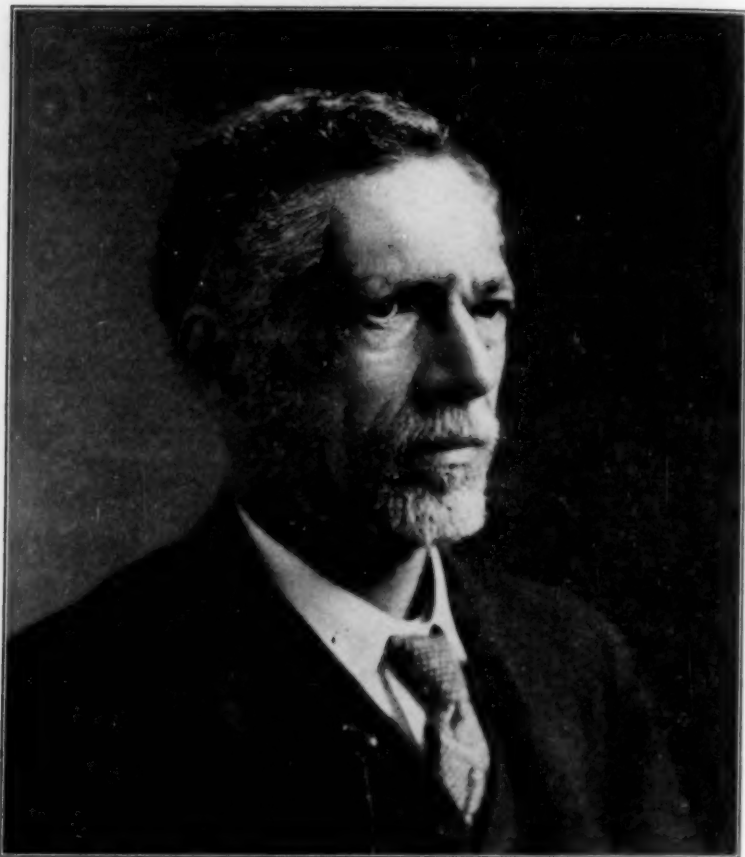
surprising if they have a higher mortality.

WILLIAM RAMSAY AND RAPHAEL MELDOLA

THE richness of England in men of scientific distinction is shown by the fact that almost every month it is necessary to record the deaths of those who have contributed in important measure to the advancement of science. It may be feared that the even more



MORTALITY FROM EPIDEMIC DISEASES IN ENGLAND AND WALES BY FIVE YEAR PERIODS TO 1910.

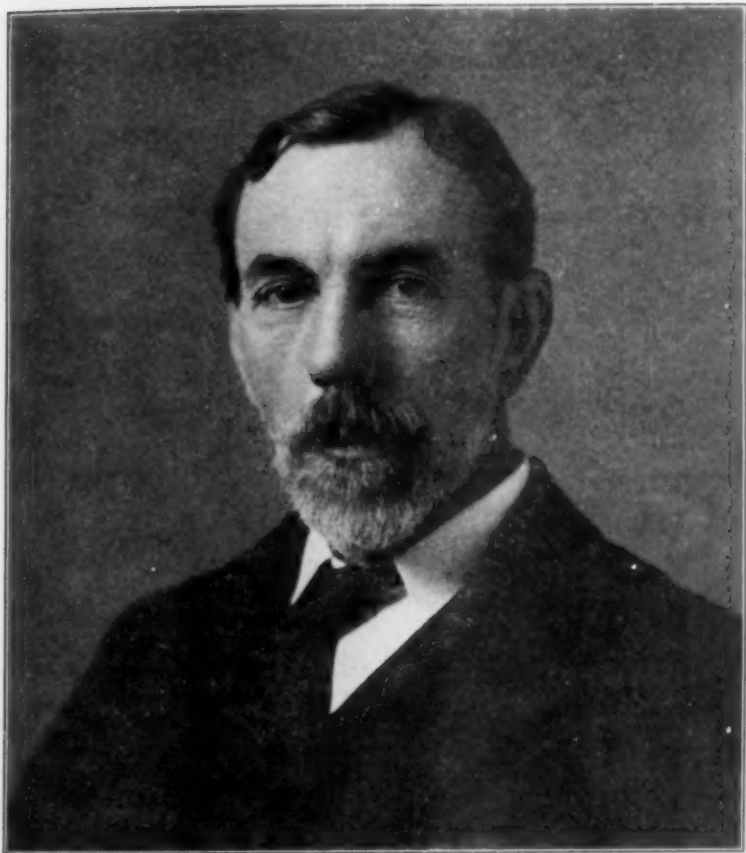


RAPHAEL MELDOLA.

numerous names of young men of promise in the scientific career who die on the battlefield and in the hospital will leave fewer men of eminence in the next generation. The equal sacrifices, we venture to say equally wanton sacrifices, in Germany, in France, in Russia and in Italy, place great responsibility on us in America to provide in the coming years the research work which is essential to the welfare and the progress of the world. We should be warned not only to save our young men of ability from futile death, but also to give them the opportunity to do the work for which they are fit.

In the death of Sir William Ramsay

and the earlier death of Professor Raphael Meldola, England has lost two chemists of world-wide reputation and of striking personality. There are not many contemporary men of science so well known as Ramsay. His earlier researches on organic chemistry, on the molecular weights of liquids and on vapor density and pressure are known to chemists, but it was the discovery, in conjunction with Lord Rayleigh, of argon, announced at the Oxford meeting of the British Association in 1894, which first attracted universal attention. However honors should be divided in the case of argon, Ramsay proceeded himself to the discovery in the uranium



WILLIAM RAMSAY.

minerals of helium, previously known only in the spectrum of the sun's chromosphere. The use of liquid air led to the discovery of three other elements of the same type, neon, krypton and xenon. Ramsay not only discovered the group of inert gases, but also described their monatomic character and their position among the elements.

Two years after the announcement of the discovery of argon, and at nearly the same time as the discovery of helium by Ramsay, Röntgen discovered the X-rays and Becquerel the rays of uranium, followed by the discovery of radium by the Curies. In the three great nations at the same time advances were in-

dependently made which gave a new direction to modern physics. To Ramsay belongs the remarkable triumph of having united the work on the inert gases and on radium by demonstrating the genesis of helium from radium. His further transformation of the elements has not been confirmed. Ostwald, who wrote in 1912 a biographical sketch of Ramsay for *Nature*, finds him an apt example of the "romantic type," which he has contrasted with the classical type. The investigator of the romantic type makes errors as well as striking discoveries and proselytes.

Ramsay's grandfather was president of what is said to have been the first

chemical society, his uncle was director to the British Geological Survey. Meldola was descended from a distinguished line of Spanish rabbis. If his grandfather had not moved to England, Meldola would have been more likely to have been a Jewish theologian than a chemist. Both Ramsay and Meldola are members of the "notable families" recorded by Galton as contributing fellows to the Royal Society. We have thus inherited ability in both cases, in the former displayed in a constant direction, in the latter diverted by the environment to a different track. In this connection it is worth noting that Meldola's performance was unusually versatile, as is indicated by the fact that he was president, on the one hand, of the British Chemical Society and the Society of Chemical Industry and, on the other hand, of the British Entomological Society and the Essex Field Club. His first papers were on mimicry and protective coloration in insects and he translated Weismann's "Theory of Descent" into English. He was for thirty years professor of chemistry in the Finsbury Technical College and conducted important researches there on the chemistry of coloring matters.

The writer of this note did not have the privilege of personal acquaintance with Meldola, but he is said to have been, like Ramsay, a man of sympathetic personality, exerting great influence on his students, active in all measures for the improvement of education and for the promotion of science.

SCIENTIFIC ITEMS

WE record with regret the death of Josiah Royce, the distinguished student of philosophy, professor at Harvard University; of Seth Low, formerly president of Columbia University; of Thomas Gregor Brodie, professor of physiology in the University of Toronto; of Sir William Henry Power, F.R.S.,

known for his contributions to sanitation and public health; and of Johannes Ranke, professor of anthropology at Munich.

SIR T. CLIFFORD ALBUTT has been elected president of the British Medical Association. A message of congratulation was at the time sent to him on the attainment of his eightieth birthday which occurred on July 20.—Professor C. F. Marvin, chief of the Weather Bureau, and Dr. L. O. Howard, chief of the Bureau of Entomology, have been appointed by the secretary of agriculture to represent the U. S. Department of Agriculture on the Council of Research which is being organized by the National Academy of Sciences.

ON the initiative of the Royal Society a Board of Scientific Societies has been established in Great Britain to promote the cooperation of those interested in pure or applied science; to supply a means by which the scientific opinion of the country may, on matters relating to science, industry and education, find effective expression; to take such action as may be necessary to promote the application of science to industries and to the service of the nation; and to discuss scientific questions in which international cooperation seems advisable. The board at present consists of representatives of twenty-seven scientific and technical societies. An executive committee has been appointed, consisting of Sir Joseph Thomson, president of the Royal Society, chairman; Dr. Dugald Clerk, F.R.S., Sir Robert Hadfield, F.R.S., Mr. A. D. Hall, F.R.S., Professor Herbert Jackson, honorary secretary, Sir Alfred Keogh, K.C.B., Sir Ray Lankester, K.C.B., F.R.S., Professor A. Schuster, secretary of the Royal Society, Sir John Snell, Professor E. H. Starling, F.R.S., Lord Sydenham, F.R.S. and Mr. R. Threlfall, F.R.S.